UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
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MEMORANDUM FOR: The Record

FROM: Rodney R. McInnis
Acting Regional Administrator
Southwest Region, National Oceanic and Atmospheric Administration,
National Marine Fisheries Service (NOAA Fisheries)

SUBJECT: Endangered Species Act section 7 programmatic biological opinion on the issuance of section 10(a)(1)(A) scientific research permits for take of threatened Central California Coast coho salmon, threatened Southern Oregon/northern California Coasts coho salmon, threatened California Coastal Chinook salmon, threatened Central California Coast steelhead, and threatened Northern California steelhead.

The attached Endangered Species Act (ESA) section 7 programmatic consultation analyzes the issuance of ESA section 10(a)(1)(A) permits for take of threatened Central California Coast coho salmon, threatened Southern Oregon/northern California Coasts coho salmon, threatened California Coastal Chinook salmon, threatened Central California Coast steelhead, and threatened Northern California steelhead. The issuance of ESA section 10(a)(1)(A) scientific research permits qualify for a categorical exclusion under the National Environmental Policy Act, therefore, an Environmental Assessment is not required for this action and has not been prepared.

NOAA Fisheries concludes that issuing scientific research permits for the activities discussed in this consultation is not likely to jeopardize the continued existence of threatened Central California Coast coho salmon, threatened Southern Oregon/northern California Coasts coho salmon, threatened California Coastal Chinook salmon, threatened Central California Coast steelhead, or threatened Northern California steelhead.

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Endangered Species Act
Section 7 Consultation

BIOLOGICAL OPINION

Endangered Species Act section 7 programmatic biological opinion on the issuance of section 10(a)(1)(A) scientific research permits for take of threatened Central California Coast coho salmon, threatened Southern Oregon/Northern California Coasts coho salmon, threatened California Coastal Chinook salmon, threatened Central California Coast steelhead, and threatened Northern California steelhead.

Agency: NOAA Fisheries

Consultation Conducted By: NOAA Fisheries, Southwest Region

Date Issued: ________________________________

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ABBREVIATIONS USED WITHIN THIS DOCUMENT

CC	California Coastal
CCC	Central California Coast
CDFG	California Department of Fish and Game
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
NC	Northern California
NOAA Fisheries *or* NMFS	National Marine Fisheries Service
PRD	Protected Resources Division
SEC	Steiner Environmental Consulting
SONCC	Southern Oregon/Northern California Coasts
SWR	Southwest Region

STANDARD UNITS OF MEASURE INCLUDED WITHIN THIS DOCUMENT

EC	degrees Celsius
mm	millimeters
cm	centimeters
cm/s	centimeters per second
m	meters
mg/l	milligrams per liter
s	seconds

I. INTRODUCTION

Section 10(a)(1)(A) of the Endangered Species Act (ESA) provides NOAA Fisheries with authority to grant exceptions to the ESA's "taking" prohibitions for scientific research (see regulations at 50 CFR 222.301 through 222.308 and 50 CFR 224.101 through 224.102). Section 10(a)(1)(A) scientific research or enhancement permits may be issued to federal or nonfederal entities conducting research or enhancement activities that involve an intentional "take"[1] of ESA-listed species. Any permitted research or enhancement activities must (1) be applied for in good faith, (2) if granted and exercised not operate to the disadvantage of the endangered species, and (3) be consistent with the purposes and policy set forth in section 2 of the ESA (50 CFR 222.303(f)). NOAA Fisheries has prepared this biological opinion in compliance with section 7(a)(2) of the ESA, as amended (16 U.S.C. 1536).

Annually, NOAA Fisheries Southwest Region (SWR) receives scores of applications for new section 10(a)(1)(A) permits or modifications to existing permits. The requirement for consultation for these permits has resulted in a substantial workload for NOAA Fisheries SWR. Currently, the backlog of pending permit actions results in poor constituent (applicant) service and does not assist in the recovery of protected species. To address these issues and in recognition that most research and monitoring activities pose limited risk to the species while offering valuable information, NOAA Fisheries SWR is developing a programmatic consultation. Recently published 4(d) rules (65 FR 42422, 67 FR 1116) highlight the value of research in the recovery process, acknowledge the paucity of research data, and encourage scientific research. A programmatic biological opinion will streamline permit issuance and expedite retrieval of information from permittees. Information collected from permit holders will contribute to the monitoring of population trends and assessing the effectiveness of protective actions. A programmatic opinion will allow NOAA Fisheries SWR to more efficiently meet its regulatory requirements and remain compliant with Federal law.

The objective of this biological opinion is to determine whether the issuance of scientific research permits is likely to jeopardize the continued existence of listed salmonids, or result in the destruction, or adverse modification of designated critical habitat. Specifically, this biological opinion evaluates the impacts from authorizing take under section 10(a)(1)(A) of the ESA for purposes of supporting the recovery of Central California Coast (CCC) coho salmon (*Oncorhynchus kisutch*), Southern Oregon Northern California Coast (SONCC) coho salmon, California Coast (CC) Chinook salmon (*O. tshawytscha*), Central California Coast (CCC) steelhead (*O. mykiss*) and Northern California (NC) steelhead through the gathering of scientific information. In preparation of this biological opinion, NOAA Fisheries SWR Protected Resources Division (PRD) identified potential actions that may be proposed under ESA section 10(a)(1)(A) programs relative to scientific research. In developing this biological opinion, NOAA Fisheries SWR PRD considered information from pertinent biological literature, written comments submitted by agencies and the public, and information derived from other sources.

[1] **Take** - to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. [ESA §3(19)]

II. DESCRIPTION OF THE PROPOSED ACTION

NOAA Fisheries SWR PRD proposes to issue ESA section 10(a)(1)(A) permits for the purpose of scientific research. Permits would be issued in accordance with the permit procedures and permit issuance criteria of 50 CFR § 222.308(c). Specific activities authorized by these permits may include: surveys by direct observation or capture by electrofisher, nets, trawls, and traps; handling, marking, tagging, attaching radio and sonic transmitters; tissue sampling; and other activities necessary to conduct various studies aimed at the recovery of the species. Only qualified individuals will be authorized to implement these actions. To facilitate the recovery planning process, all data collected as a result of the permitted actions will be reported to NOAA Fisheries SWR PRD for distribution to the Southwest Fisheries Science Center and Area Recovery Coordinators.

Under the tiered consultation framework, individual entities will submit an application for either a new ESA section 10(a)(1)(A) permit or to modify an existing ESA section 10(a)(1)(A) permit. NOAA Fisheries SWR will review all research proposals to insure that they are consistent with the purposes of the ESA.

A. Evaluating Future Research Projects

Issuance of permits would be restricted to only those entities performing activities that enhance the propagation or survival of ESA-listed salmonids. In addition, NOAA Fisheries must determine whether the action is likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The standards for determining jeopardy are set forth in section 7(a)(2) of the ESA and in 50 CFR 402 (the consultation regulations). This analysis involves the initial steps of: (1) defining the biological requirements of the listed species; and (2) evaluating the species' current status as listed and within the action area. Subsequently, NOAA Fisheries evaluates whether the action is likely to jeopardize the listed species by determining if the effects of the action and the cumulative effects, when added to the baseline and the species' current status, would be expected, directly or indirectly, to reduce appreciably the likelihood of survival and recovery of the species in the wild. If NOAA Fisheries finds that the action is likely to jeopardize listed salmonids, NOAA Fisheries must identify reasonable and prudent alternatives for the action.

Before issuing section 10(a)(1)(A) permits under this opinion, NOAA Fisheries will prepare a memorandum analyzing the expected effects of implementing the proposed action. The analysis will evaluate the proposed activity and ensure that the proposed action satisfies the NOAA Fisheries permit issuance criteria of 50 CFR § 222.308(c). The memorandum will tier to this biological opinion, when appropriate, to eliminate repetitive discussions of some issues and to focus on issues specific to the proposed action not already analyzed in this opinion. In addition to the tiered analysis, NOAA Fisheries will prepare a document which includes: a list of public comments received on the proposed project and responses to those comments; a discussion of compliance for all requirements of the National Environmental Policy Act and the Magnuson-Stevens Fisheries Conservation and Management Act; and a discussion of coordination among NOAA Fisheries SWR, NOAA Fisheries Southwest Fisheries Science Center, United States Fish and Wildlife Service, and the National Ocean Service.

The following research activities, given their high inherent risk of injury or mortality to salmonids, would require additional impact analysis: multi-pass backpack electrofishing, boat-based electrofishing, intentional adult capture, use of gillnets, enhancement activities, and experimental relocations. Permit applications for these and other high-risk activities would be subject to additional detailed assessment of effects in the tiered analysis. Intentional lethal take of listed salmonids, a rare research request, is not covered by this opinion and will be subject to separate consultation should the need arise.

As part of this programmatic consultation, NOAA Fisheries will reinitiate consultation approximately one year from issuance of this biological opinion to reassess research projects authorized herein to ensure that they benefit the conservation of CCC and SONCC coho salmon, CC Chinook salmon, and CCC and NC steelhead. Prior to reinitiation, NOAA Fisheries SWR field offices will be responsible for making specific determinations to ensure that take authorized under this program does not reduce the potential for listed anadromous fish populations to survive and recover on an ESU-scale or adversely modify designated critical habitat.

B. Description of the Action Area

The action area includes all coastal California streams from Aptos Creek in Santa Cruz County north to the Oregon/California border and all streams draining into San Francisco and San Pablo bays eastward to the Napa River (inclusive), excluding the Sacramento-San Joaquin River Basin (Figure 1). The action area encompasses the geographic areas included within the CCC coho salmon, CC Chinook salmon, CCC steelhead, and NC steelhead Evolutionarily Significant Units[2] (ESU), and the portions of the SONCC coho salmon ESU in California (Figure 2).

III. DESCRIPTION AND STATUS OF THE SPECIES AND CRITICAL HABITAT

This biological opinion analyzes the effects of the proposed permit issuance program on the following listed species: More detailed information related to the listing status, critical habitat, protective regulations, and biological information for the ESA-listed species addressed in this opinion are found in Table 1.

Coho Salmon (Oncorhynchus kisutch)

Southern Oregon/Northern California Coast (SONCC) ESU, listed as threatened on May 6, 1997 (62 FR 24588)

Central California Coast (CCC) ESU, listed as threatened under the ESA on October 31, 1996 (61 FR 56138)

Chinook Salmon (Oncorhynchus tshawytscha)

California Coastal (CC) Chinook salmon, listed as threatened under the ESA on September 16, 1999 (64 FR 50394)

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[2] For purposes of conservation under the Endangered Species Act, an Evolutionarily Significant Unit (ESU) is a distinct population segment that is substantially reproductively isolated from other conspecific population units and represents an important component in the evolutionary legacy of the species (Waples 1991).

Steelhead (Oncorhynchus mykiss)

Northern California (NC) steelhead ESU, listed as threatened under the ESA on June 7, 2000 (65 FR 36074)

Central California Coast (CCC) steelhead, listed as threatened under the ESA on August 18, 1997 (62 FR 43937)

The research activities NOAA Fisheries expects to cover with this programmatic opinion do not result in any changes or effects to salmonid habitat. Therefore, critical habitat is not likely to be affected by the proposed permit issuance program and is not considered further in this opinion.

A. Coho Salmon

1. Species Description

Coho salmon were first described in 1792 as *Salmo kisutch* by Walbaum from specimens collected in Kamchatka, Russia (Scott and Crossman 1973). The trivial name of coho given by Walbaum was the vernacular name used for coho in Kamchatka, the location of the collections used in Walbaum's description. Since Walbaum's original description, coho salmon has been described as *Salmo kisutch*, *S. kysutch*, *S. macrostoma*, *S. milktschitch, S. sanguinolentus*, *S. scouleri, S. striatus*, *S. tsuppitch, Oncorhynchus kisutch*, *O. lycaodon, O. sanguinolentus,* and *O. tsuppitch* (Jordan and Evermann 1896; Jordan *et al*. 1930; Scott and Crossman 1973). The currently accepted scientific name for coho salmon is *Oncorhynchus kisutch* (Robins *et al*. 1991). Coho salmon, as with the other Pacific salmon, have been known by many colloquial names as well (Jordan *et al*. 1930; Scott and Crossman 1973).

Coho salmon are native to the north Pacific Ocean. The historic distribution of coho salmon in North America included coastal streams from Alaska south to northwestern Mexico (Moyle 1976; Weitkamp *et al*. 1995). Currently the San Lorenzo River in Santa Cruz County, California is thought to have the southern-most persistent population of coho salmon in North America (Weitkamp *et al*. 1995). Coho salmon are also found in Asia from the Anadyr River, Russia, south to Hokkaido, Japan and tributaries of Peter the Great Bay on the Sea of Japan (Hart 1973; Sandercock 1991).

2. Listing Status

On October 27, 1993, NOAA Fisheries published a notice (58 FR 57770) soliciting information about the status of all populations of coho salmon in Washington, Oregon, and California. NOAA Fisheries determined that such an expanded status review was warranted due to the general decline in many West Coast coho salmon populations. NOAA Fisheries established a Biological Review Team, comprised of staff from its Northwest Fisheries Science Center and Southwest Regional Office, and completed a coastwide status review for coho salmon (Weitkamp *et al*. 1995). NOAA Fisheries determined that two ESUs of coho salmon are present in California: CCC coho salmon and SONCC coho salmon.

a. *CCC Coho Salmon*

On October 31, 1996, NOAA Fisheries issued a final determination that the CCC coho salmon ESU are a "species" under the ESA, and that it would be listed as a threatened species (61 FR 56138); the effective date of the determination was December 2, 1996. In a technical correction to the final listing determination (62 FR 1296), NOAA Fisheries defined the CCC coho salmon

ESU to include all coho salmon naturally-reproduced in streams between Punta Gorda in Humboldt County, California, and the San Lorenzo River in Santa Cruz County, California (inclusive), and included tributaries to San Francisco Bay. The taking of this species was prohibited, pursuant to section 4(d) and section 9 of the ESA in the final rule (61 FR 56138).

b. *SONCC Coho Salmon*

On May 6, 1997, NOAA Fisheries issued a final rule that the SONCC coho salmon ESU are a "species" under the ESA, and that it would be listed as a threatened species (62 FR 24588), effective on June 5, 1997. The SONCC coho salmon ESU includes all coho salmon naturally-reproduced in coastal streams between Cape Blanco, Oregon, and Punta Gorda, California. On July 18, 1997, NOAA Fisheries published an interim rule that identified several exceptions to the ESA's section 9 take prohibitions for SONCC coho salmon (62 FR 38479); this interim rule is still in effect.

3. Status of Stocks

A comprehensive review of estimates of historic abundance, decline and present status of coho salmon in California is provided by Brown *et al*. (1994). They estimated that coho salmon annual spawning populations in California ranged between 200,000 and 500,000 fish in the 1940s, which declined to about 100,000 fish by the 1960s, followed by a further decline to about 31,000 fish by 1991, of which 57 percent were artificially propagated. The other 43 percent (13,240) were natural spawners, which included naturally-produced, wild fish and naturalized (hatchery-influenced) fish. Brown *et al*. (1994) cautioned that this estimate could be overstated by 50 percent or more. Of the 13,240, only about 5,000 were naturally-produced, wild coho salmon without hatchery influence, and many of these were in individual stream populations of less than 100 fish each. In summary, Brown *et al*. (1994) concluded that the California coho salmon population had declined more than 94 percent since the 1940s, with the greatest decline occurring since the 1960s. Brown and Moyle (1991) stated that 46 percent of California streams which historically supported coho salmon populations, and for which recent data were available, no longer supported runs.

No regular spawning escapement estimates exist for natural coho salmon in California streams. The CDFG (1994) summarized most information for northern California coho salmon. They concluded that "coho salmon in California, including hatchery populations, could be less than six percent of their abundance during the 1940s, and have experienced at least a 70 percent decline in the 1960s." Further, they reported that coho salmon populations have been virtually eliminated in many streams, and that adults are observed only every third year in some streams, suggesting that two of three brood cycles may already have been eliminated.

a. *CCC Coho Salmon*

NOAA Fisheries' status review (Weitkamp *et al*. 1995) concluded that abundance data for the CCC coho salmon ESU were very limited. Recent population estimates vary from approximately 600 to 5,500 adults (Brown *et al*. 1994). Brown *et al*. (1994) estimated average annual coho salmon spawning escapement for the period from the early 1980s through 1991 was 6,160 naturally spawning fish and 332 artificially propagated fish. Of the naturally-spawning coho salmon, 3,880 were from the tributaries in which supplementation occurs (Noyo River and several coastal streams south of San Francisco). Although stated in the status review that 160 fish in the range of this ESU (all in Ten Mile River) were identified as native fish, lacking a history of supplementation with non-native hatchery stocks (Table 2), Maahs and Gilleard (1993) reported that 200,000 coho salmon from Oregon were planted annually in the Ten Mile River between 1974 and 1977, with an additional 44,000 planted in 1978.

Of 186 streams in the range of the CCC coho salmon ESU identified as having historic accounts of adult coho salmon, recent data exist for 133 streams (Brown *et al*. 1994). Of these 133 streams, 62 streams have recent records of occurrence of adult coho salmon and 71 streams no longer maintain coho salmon spawning runs (Table 3). Nehlson *et al*. (1991) provided no information on individual coho salmon stocks in this region, but identified stocks in small coastal streams north of San Francisco as at moderate risk of extinction, and those in small coastal streams south of San Francisco as at high risk of extinction. Higgins *et al*. (1992) considered only drainages from the Russian River north but identified four coho salmon stocks within this ESU as at risk: three of special concern and one (Gualala River) as at high risk of extinction.

Weitkamp *et al*. (1995) concluded that all coho salmon stocks south of Punta Gorda were depressed relative to past abundance, but there were limited data to assess population numbers or trends. The main stocks in this region have been heavily influenced by hatcheries, and there are apparently few native coho salmon left. The apparent low escapements in these rivers and streams, in conjunction with heavy historical hatchery production, suggest that natural populations are not self-sustaining. Adams *et al*. (1999) found that for the three-year period between 1995 to 1997 coho salmon were present in 51 percent (98 of 191) of the streams where they were historically present, and documented an additional 23 streams, within the CCC coho salmon ESU, in which coho salmon were found for which there were no historical records. NOAA Fisheries (2001a) found continued decline of coho salmon in this ESU, even in streams which had previously had stable populations of coho salmon.

b. *SONCC Coho Salmon*

All coho salmon stocks between Punta Gorda and Cape Blanco are depressed relative to past abundance, but again there are limited data to assess population numbers or trends (Weitkamp *et al.* 1995). The main stocks in this ESU (Rogue River, Klamath River, and Trinity River) are heavily influenced by hatcheries and, apparently, have little natural production in mainstem rivers. The apparent declines in production in these rivers, in conjunction with heavy hatchery production, suggest that the natural populations are not self-sustaining. The status of coho salmon stocks in most small coastal tributaries is not well known, but these populations are small.

4. <u>Life History and Biological Requirements</u>

Coho salmon are typically associated with small to moderately-sized coastal streams characterized by heavily forested watersheds; perennially-flowing reaches of cool, high-quality water; dense riparian canopy; deep pools with abundant overhead cover; instream cover consisting of large, stable woody debris and undercut banks; and gravel or cobble substrates.

The life history of the coho salmon in California has been well documented by Shapovalov and Taft (1954) and Hassler (1987). In contrast to the life history patterns of other anadromous salmonids, coho salmon in California generally exhibit a relatively simple 3-year life cycle (Shapovalov and Taft 1954; Hassler 1987). Adult salmon typically begin the freshwater migration from the ocean to their natal streams after heavy late-fall or winter rains breach the sand bars at the mouths of coastal streams (Sandercock 1991). Delays in river entry of over a month are not unusual (Salo and Bayliff 1958; Eames *et al*. 1981). Migration continues to March, generally peaking in December and January, with spawning occurring shortly after returning to the spawning ground (Shapovalov and Taft 1954).

Female coho salmon choose spawning sites usually near the head of a riffle, just below a pool, where water changes from a laminar to a turbulent flow and there is small to medium gravel substrate. The flow characteristics of the location of the redd usually insure good aeration of eggs and embryos, and flushing of waste products. The water circulation in these areas also facilitates fry emergence from the gravel. Preferred spawning grounds have nearby overhead and submerged cover for holding adults; water depth of 10-54 cm; water velocities of 20-80 cm/s; clean, loosely compacted gravel (1.3-12.7 cm diameter) with less than 20 percent fine silt or sand content; cool water (4-10EC) with high dissolved oxygen (8 mg/l); and an intergravel flow sufficient to aerate the eggs. The lack of suitable gravel often limits successful spawning in many streams.

Each female builds a series of redds, moving upstream as she does so, and deposits a few hundred eggs in each. Fecundity of coho salmon is directly proportional to female size; coho salmon may produce from 1000-7600 eggs (reviewed in Sandercock 1991). Briggs (1953) noted a dominant male accompanies a female during spawning, but one or more subordinate males also may engage in spawning. Coho salmon may spawn in more than one redd and with more than one partner (Sandercock 1991). Coho salmon are semelparous. The female may guard a nest for up to two weeks (Briggs 1953).

The eggs generally hatch between 4 to 8 weeks, depending on water temperature. Survival and development rates depend on temperature and dissolved oxygen levels within the redd. According to Baker and Reynolds (1986), under optimum conditions, mortality during this period can be as low as 10 percent; under adverse conditions of high scouring flows or heavy siltation, mortality may be close to 100 percent. McMahon (1983) found that egg and fry survival drops sharply when fines make up 15 percent or more of the substrate. The newly-hatched fry remain in the gravel from two to seven weeks until emergence from the gravels (Shapovalov and Taft 1954). Upon emergence, fry seek out shallow water, usually along stream margins. As they grow, they often occupy habitat at the heads of pools, which generally provide an optimum mix of high food availability and good cover with low swimming cost (Nielsen 1992). Chapman and Bjornn (1969) determined that larger parr tend to occupy the head of pools, with smaller parr found further down the pools. As the fish continue to grow, they move into deeper water and expand their territories until, by July and August, they are in the deep pools. Juvenile coho salmon prefer well shaded pools at least 1 m deep with dense overhead cover; abundant submerged cover composed of undercut banks, logs, roots, and other woody debris; preferred water temperatures of 12-15EC (Brett 1952; Reiser and Bjornn 1979), but not exceeding 22-25EC (Brungs and Jones 1977) for extended time periods; dissolved oxygen levels of 4-9 mg/l; and water velocities of 9-24 cm/s in pools and 31-46 cm/s in riffles. Water temperatures for good survival and growth of juvenile coho salmon range from 10-15EC (Bell

1973; McMahon 1983). Growth is slowed considerably at 18EC and ceases at 20EC (Stein *et al*. 1972; Bell 1973).

Preferred rearing habitat has little or no turbidity and high sustained invertebrate forage production. Juvenile coho salmon feed primarily on drifting terrestrial insects, much of which are produced in the riparian canopy, and on aquatic invertebrates growing in the interstices of the substrate and in the leaf litter in the pools. As water temperatures decrease in the fall and winter months, fish stop or reduce feeding due to lack of food or in response to the colder water, and growth rates slow down. During December-February, winter rains result in increased stream flows and by March, following peak flows, fish again feed heavily on insects and crustaceans and grow rapidly.

In the spring, as yearlings, juvenile coho salmon undergo a physiological process, known as smoltification, which prepares them for living in the marine environment. They begin to migrate downstream to the ocean during late March and early April, and out migration usually peaks in mid-May, if conditions are favorable. At this point, the smolts are about 10-13 cm in length. After entering the ocean, the immature salmon initially remain in nearshore waters close to their parent stream. They gradually move northward, staying over the continental shelf (Brown *et al*. 1994). Although they can range widely in the North Pacific, movements of coho salmon from California are poorly known.

B. Chinook Salmon

1. Species Description

Chinook salmon was first described in 1792 by Walbaum as *Salmo tshawytscha* (Scott and Crossman 1973). The trivial name of Chinook salmon given by Walbaum was the vernacular name used for Chinook salmon in Kamchatka, Russia, the location of the original collections. Since Walbaum's original description, Chinook salmon has been described by at least eleven different scientific names in three genera, and by at least eight common or colloquial names (Jordan *et al*. 1930; Scott and Crossman 1973). Currently, Chinook salmon are referred to as *Oncorhynchus tshawytscha* (Robins *et al*. 1991).

Chinook salmon historically ranged from the Ventura River in southern California north to Point Hope, Alaska, and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia (Healey 1991). Myers *et al*. (1998) reports no viable populations of Chinook salmon south of San Francisco, California, though captures of Chinook salmon have been reported from the Guadalupe River (David Salsbery. Fisheries Biologist. Santa Clara Valley Water District. San Jose, California. Personal communication). Although Chinook salmon are a wide-ranging species, it is the least abundant Pacific salmon in North America (Moyle 1976; Page and Burr 1991).

2. Listing Status

In reviewing the biological and ecological information concerning west coast Chinook salmon, NOAA Fisheries identified 11 ESUs for Chinook salmon from Washington, Oregon, and California (Myers *et al*. 1998). Initially, the CC Chinook salmon ESU was described as the Southern Oregon and Northern California Chinook salmon ESU (63 FR 11482). The Southern Oregon and Northern California Chinook salmon ESU included all naturally-spawned, coastal, spring and fall Chinook salmon spawning from Cape Blanco, Oregon to the southern extent of the current range for Chinook salmon at Point Bonita, California (the northern landmass marking the entrance to San Francisco Bay). On September 16, 1999, NOAA Fisheries issued a final determination stating that new information supported splitting the Southern Oregon and Northern California Chinook salmon ESU into two ESUs - the Southern Oregon and Northern California Chinook salmon ESU and the CC Chinook salmon ESU (64 FR 50394). The CC Chinook salmon ESU consists of coastal Chinook salmon populations from Redwood Creek (Humboldt County) south through the Russian River. Other coastal populations to the north of the CC Chinook salmon ESU (and originally proposed as threatened) were considered part of a separate Southern Oregon and Northern California Coastal ESU that did not warrant listing at that time (63 FR 11482). On January 9, 2002 NOAA Fisheries promulgated take prohibitions for CC Chinook salmon (67 FR 1116).

3. Status of Stocks

Although northern coastal California streams support small, sporadically monitored populations of fall-run Chinook salmon, estimates of absolute population abundance are not available for most populations encompassing this ESU (Myers *et al*. 1998; NOAA Fisheries 1999a). Trends in fall Chinook salmon abundance in those California streams that are monitored are mixed; in general, the trends tend to be more negative in streams that are farther south along the coast. Although there are no monitoring programs in place to estimate abundance, there are a few indexed surveys occurring showing that trends of Chinook salmon in the Mad River, Eel River, and Mattole River continue to decline (NOAA Fisheries 1999a). In contrast though, between 1992 and 1998 the number of Chinook salmon appearing at the Coyote Valley Fish Facility on the Russian River is increasing (NOAA Fisheries 1999a); however, the document does not discriminate whether the Chinook salmon were naturally-produced or hatchery-produced[3]. In 1999, the Sonoma County Water Agency (SCWA) initiated a pilot study to identify and enumerate salmonids - including Chinook salmon - passing through fish ladders on the lower mainstem Russian River. The SCWA operates screw traps immediately downstream of the inflatable Mirabel Dam to capture emigrating juveniles and video cameras within the fish ladders of the dam to document immigrating adults. Sampling efficiency, gear specifications, and effort change annually, therefore it is not possible to confirm that the numbers of Chinook salmon encountered correlate with Chinook salmon abundance. However, the data can be first-order evidence that Chinook salmon are periodically present annually within the Russian River. Also, the SCWA sampling regime probably does not encompass the entire migration period for Chinook salmon and turbid water reduces the efficiency of video counts. The number of juvenile and adult Chinook salmon observed by the SCWA appear in Table 4.

4. Life History and Biological Requirements

Chinook salmon are anadromous and the largest member of *Oncorhynchus*, with adults weighing more than 120 pounds having been reported from North American waters (Scott and Crossman 1973; Eschmeyer *et al*. 1983; Page and Burr 1991). Chinook salmon exhibit two main life

[3] The California Department of Fish and Game (CDFG) has managed the Coyote Valley Fish Facility and the Don Claussen Fish Hatchery (United States Army Corps of Engineers facilities on the Russian River) since 1992 and raised Chinook salmon, coho salmon, and steelhead. Production and release of Chinook salmon and coho salmon at the Russian River facilities was discontinued in 1999 and 1998 respectively.

history strategies: ocean-type fish and river-type fish (Healey 1991). Ocean-type fish typically are fall- or winter-run fish that typically enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of rivers, spawn within a few weeks of freshwater entry and have offspring that emigrate shortly after emergence from the redd (Healey 1991). River-type fish are typically spring- or summer-run fish that have a protracted adult freshwater residency, sometimes spawning several months after entering freshwater. Progeny of river-type fish frequently spend one or more years in freshwater before emigrating.

Chinook salmon in the CC Chinook salmon ESU generally remain in the ocean for two to five years (Healey 1991), and tend to stay along the California and Oregon coasts. Some Chinook salmon return from the ocean to spawn one or more years before becoming full-sized adults, and are referred to as jacks (males) and jills (females). Myers *et al*. (1998) and Fukushima and Lesh (1998) document immigration timing for Chinook salmon throughout the action area; typically, immigration occurs between August and November. Spawning of Chinook salmon in northern California occurs from October through February (Myers *et al*. 1998).

Egg deposition must be timed to insure that fry emerge during the following spring at a time when the river or estuary productivity is sufficient for juvenile survival and growth. Adult female Chinook salmon prepare redds in stream areas with suitable gravel composition, water depth, and velocity. Spawning generally occurs in swift, relatively shallow riffles or along the edges of fast runs at depths greater than 24 cm. Optimal spawning temperatures range between 5.6-13.9EC. Redds vary widely in size and location within the river. Preferred spawning substrate is clean, loose gravel, mostly sized between 1.3-10.2 cm (Allen and Hassler 1986). Embryo survival is strongly correlated with the proportion of substrates in the range of 0.85 mm to 9.50 mm. Survival decreases significantly as the percent of 0.85 mm material increases beyond 10 percent and as 9.50 mm material increases beyond 25 percent (Tappel and Bjornn 1983). Reiser and White (1988) indicated dramatic decreases in survival with fines (<0.84 mm) greater than 10 percent. Geometric mean particle size diameters of 8 mm to 15 mm also result in a marked reduction in survival of Chinook embryos (Shirazi and Seim 1979; Tappel and Bjornn 1983). Gravels are unsuitable when they have been cemented with clay or fines or when sediments settle out onto redds, reducing intergravel percolation (62 FR 24588). Minimum intragravel percolation rate depends on flow rate, water depth, and water quality. The percolation rate must be adequate to maintain oxygen delivery to the eggs and remove metabolic wastes. The Chinook salmon's need for a strong, constant level of subsurface flow may indicate that suitable spawning habitat is more limited in most rivers than superficial observation would suggest. After depositing eggs in a redd, adult Chinook salmon guard the redd from 4 to 25 days before dying.

Chinook salmon eggs incubate for 90 to 150 days, depending on water temperature. Successful incubation depends on several factors including dissolved oxygen levels, temperature, substrate size, amount of fine sediment, and water velocity. Maximum survival of incubating eggs and pre-emergent fry occurs at water temperatures between 5.6-13.3EC with a preferred temperature of 11.1EC. Fry emergence begins in December and continues into mid-April (Leidy and Leidy 1984). Emergence can be hindered if the interstitial spaces in the redd are not large enough to permit passage of the fry. In laboratory studies, Bjornn and Reiser (1991) observed that Chinook salmon and steelhead fry had difficulty emerging from gravel when fine sediments (6.4 mm or less) exceeded 30-40 percent by volume.

After emergence, Chinook salmon fry seek out areas behind fallen trees, back eddies, undercut banks and other areas of bank cover (Everest and Chapman 1972). As they grow larger, their habitat preferences change. Juveniles move away from stream margins and begin to use deeper water areas with slightly faster water velocities, but continue to use available cover to minimize the risk of predation and reduce energy expenditure. Fish size appears to be positively correlated with water velocity and depth (Chapman and Bjornn 1969; Everest and Chapman 1972). Optimal temperatures for both Chinook salmon fry and fingerlings range from 12-14EC, with maximum growth rates at 12.8EC (Boles 1988). Chinook feed on small terrestrial and aquatic insects and aquatic crustaceans. Cover, in the form of rocks, submerged aquatic vegetation, logs, riparian vegetation, and undercut banks provide food, shade, and protect juveniles from predation.

The low flows, high temperatures, and sand bars that develop in smaller coastal rivers during the summer months favor an ocean-type life history (Kostow 1995). With this life history, smolts typically outmigrate as subyearlings during April through July (Myers *et al.* 1998). The ocean-type Chinook salmon in California tend to use estuaries and coastal areas for rearing more extensively than stream-type Chinook salmon. The brackish water areas in estuaries moderate the physiological stress that occurs during parr-smolt transitions.

C. Steelhead

1. Species Description

The taxonomic history and nomenclature of steelhead, the anadromous form of rainbow trout, is complex and difficult to reconcile. The species has been described with at least 22 scientific names in 5 genera and is known by many common or colloquial names (Jordan *et al*. 1930; Scott and Crossman 1973). In 1792 Walbaum described the Kamchatcha trout as *Salmo mykiss* and in 1836 Richardson described the rainbow trout from the Columbia River as *Salmo gairdneri* (Smith and Stearley 1989). The Kamchatcha trout and rainbow trout were thought to be separate species until recently when Smith and Stearley (1989) synonomized the Kamchatcha trout with rainbow trout under the name *Oncorhynchus mykiss*. Steelhead are native to the north Pacific Ocean and in North America are found in coastal streams from Alaska south to northwestern Mexico (Moyle 1976; Busby *et al*. 1996). At this time NOAA Fisheries has listed only the anadromous life form of rainbow trout - steelhead.

2. Listing Status

In February 1994, NOAA Fisheries received a petition seeking protection under the ESA for 178 populations of steelhead in Washington, Idaho, Oregon, and California. At the time, NOAA Fisheries was conducting a status review of coastal steelhead populations in Washington, Oregon, and California. In response to the broader petition, NOAA Fisheries expanded the ongoing review to include inland steelhead occurring east of the Cascade Mountains in Washington, Idaho, and Oregon. After considering biological and environmental information, NOAA Fisheries identified 15 ESUs; 12 for coastal steelhead and 3 for the inland form (Busby *et al*. 1996).

a. *CCC Steelhead*

On August 18, 1997, NOAA Fisheries issued a final determination that the CCC steelhead ESU was a "species" under the ESA and that it will be listed as a threatened species (62 FR 43937). The CCC steelhead ESU includes all naturally-produced steelhead (and their progeny) in coastal California streams from the Russian River to Aptos Creek, and the drainages of San Francisco and San Pablo Bays eastward to the Napa River (inclusive), excluding the Sacramento-San Joaquin River Basin. On December 30, 1999, NOAA Fisheries published in the *Federal Register* a proposed 4(d) rule for CCC steelhead (64 FR 73479). Take prohibitions went into effect, via the 4(d) rule, with the effective date of September 8, 2000 (65 FR 42422).

b. *NC Steelhead*

Following completion of a comprehensive status review of west coast steelhead (*Oncorhynchus mykiss*, or *O. mykiss*) populations throughout Washington, Oregon, Idaho, and California, NOAA Fisheries published a proposed rule to list 10 ESUs as threatened or endangered under the ESA on August 9, 1996. One of these steelhead ESUs, the Northern California ESU, was proposed for listing as a threatened species. Because of scientific disagreements, NOAA Fisheries deferred its final listing determination for five of these steelhead ESUs, including the Northern California ESU, on August 18, 1997. After soliciting and reviewing additional information to resolve these disagreements, NOAA Fisheries published a final rule in March 1998 that the Northern California ESU did not warrant listing under the ESA because available scientific information and conservation measures indicated the ESU was at a lower risk of extinction than at the time of the proposed rule. Because the State of California did not implement conservation measures that NOAA Fisheries considered critically important in its decision to not list the Northern California steelhead ESU, NOAA Fisheries completed an updated status review for the ESU and reassessed the State and Federal conservation measures that were in place to protect the ESU. Based on this reconsideration, NOAA Fisheries proposed to list the Northern California steelhead ESU as a threatened species under the ESA on February 11, 2000. On June 7, 2000, NOAA Fisheries published a final determination that NC steelhead would be listed as threatened under the ESA effective August 7, 2000 (65 FR 36074). On January 9, 2002 NOAA Fisheries promulgated take prohibitions for NC steelhead (67 FR 1116).

The NC steelhead ESU includes naturally-produced steelhead in California coastal river basins from Redwood Creek south to the Gualala River, inclusive. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 6,672 square miles in California. The following counties lie partially or wholly within these basins: Del Norte, Glenn, Humboldt, Lake, Mendocino, Sonoma, and Trinity.

3. <u>Status of Stocks</u>

a. *CCC Steelhead*

Only two estimates of historic (pre-1960s) abundance specific to this ESU are available: an average of about 500 adults in Waddell Creek in the 1930s and early 1940s (Shapovalov and Taft 1954), and 20,000 steelhead in the San Lorenzo River before 1965 (Johnson 1964). In the mid-1960s, 94,000 adult steelhead were estimated to spawn in the rivers of this ESU, including 50,000 fish in the Russian River and 19,000 fish in the San Lorenzo River (CDFG 1965). Recent estimates indicate an abundance of about 7,000 adult steelhead in the Russian River and about 500 fish in the San Lorenzo River. These estimates suggest that recent total abundance of steelhead in these two rivers is less than 15 percent of their abundance in the mid 1960s. Recent estimates for several other streams (Lagunitas Creek, Waddell Creek, Scott Creek, San Vincente Creek, Soquel Creek, and Aptos Creek) indicate individual run sizes of 500 fish or less. Steelhead in most tributaries to San Francisco and San Pablo bays have been virtually extirpated (McEwan and Jackson 1996). Fair to good runs of steelhead still apparently occur in coastal Marin County tributaries. In a 1994 to 1997 survey of 30 San Francisco Bay watersheds, steelhead occurred in small numbers at 41 percent of the sites, including the Guadalupe River, San Lorenzo Creek, Corte Madera Creek, and Walnut Creek (Leidy 1997). While there are several concerns with these data (e.g., uncertainty regarding origin of juveniles), NOAA Fisheries believes it is generally a positive indicator that there is a relatively broad distribution of steelhead in smaller streams throughout the region.

Little information is available regarding the contribution of hatchery-produced fish to natural spawning of steelhead, and little information on present run sizes or trends for this ESU exists. However, given the substantial rates of declines for stocks where data do exist, the majority of natural production in this ESU is likely not self-sustaining (62 FR 43937).

b. *NC Steelhead*

Busby *et al*. (1996) provides a comprehensive review of estimates of historic abundance, decline and present status of steelhead in western United States. They reviewed previous assessments within this ESU which identified several stocks as being at risk or of special concern. Nehlson *et al*. (1991) identified three stocks as at risk of extinction: summer steelhead in Redwood Creek, Mad River, and Eel River. Higgins *et al*. (1992) provided a more detailed analysis of some of these stocks and identified 11 summer steelhead stocks as at risk or of concern.

Estimates of historical (pre-1960s) abundance specific to this ESU were available from dam counts in the upper Eel River (Cape Horn Dam--annual average of 4,400 adult steelhead in the 1930s; McEwan and Jackson 1996), the South Fork Eel River (Benbow Dam--annual average of 19,000 adult steelhead in the 1940s; McEwan and Jackson 1996), and the Mad River (Sweasey Dam--annual average of 3,800 adult steelhead in the 1940s; Murphy and Shapovalov 1951, CDFG 1994). In the mid-1960s, CDFG (1965, table S-3) estimates steelhead spawning populations for many rivers in this ESU totaled 198,000. Estimated total run size for the major stocks in California (entire state) for the early 1980s was given by Light (1987) as approximately 275,000. Of these, 22% were of hatchery origin, resulting in a naturally produced run size of 215,000 steelhead. Roughly half of this production was thought to be in the Klamath River Basin (including the Trinity River), so the total natural production for all ESUs south of Punta Gorda was probably on the order of 100,000 adults. The only current run-size estimates for this area are counts at Cape Horn Dam on the Eel River where an average of 115 total and 30 wild adults were reported (McEwan and Jackson 1996). Although there is no estimate of total abundance for this ESU, steelhead appear widely distributed throughout the region.

Busby *et al*. (1996) computed adult escapement trends for seven stocks within this ESU. Of these, five data series exhibit declines and two exhibit increases during the available data series, with a range from 5.8% annual decline to 3.5% annual increase. Three of the declining trends were significantly different from zero. For one long data set (Eel River, Cape Horn Dam counts), a separate trend for the last 21 years (1971-91) was calculated for comparison: while the full-series trend showed significant decline, the recent data showed a lesser, nonsignificant decline, suggesting that the major stock decline occurred prior to 1970. There has been little change in Northern California steelhead ESU status recently. Adams (2000) states that trend numbers have shown small increases, but there are no substantial changes in abundance of NC steelhead.

Hatchery fish are widespread and escaping to spawn naturally throughout the region. According to McEwan and Jackson (1996, p. 37), "despite the large number of hatchery smolts released, steelhead runs in north coast drainages are comprised mostly of naturally produced fish." We have little information on the actual contribution of hatchery fish to natural spawning, and little information on present total run sizes for this ESU. However, given the preponderance of significant negative trends in the available data, there is concern that steelhead populations in this ESU may not be self-sustaining. The major present threat to genetic integrity for steelhead in this ESU comes from past and present hatchery practices. Within this ESU, we have no information regarding spatial or temporal separation of spawning hatchery and natural fish, but there is probably sufficient overlap for some genetic introgression to occur.

4. Life History and Biological Requirements

Steelhead spend anywhere from one to five years in saltwater, however, two to three years are most common (Busby *et al*. 1996). Some return as "half-pounders" that over-winter one season in freshwater before returning to the ocean in the spring. The distribution of steelhead in the ocean is not well known. Coded wire tag recoveries indicate that most steelhead tend to migrate north and south along the continental shelf (Barnhart 1986).

Steelhead can be divided into two reproductive ecotypes, based upon their state of sexual maturity at the time of river entry and the duration of their spawning migration: stream maturing and ocean maturing. Stream maturing steelhead enter fresh water in a sexually immature condition and require several months to mature and spawn; whereas ocean maturing steelhead enter fresh water with well developed gonads and spawn shortly after river entry. These two reproductive ecotypes are more commonly referred to by their season of freshwater entry (i.e., summer [stream maturing] and winter steelhead [ocean maturing]). Adult summer steelhead typically oversummer in pools. Freshwater distribution of adult summer steelhead is affected by pool dimension, the amount and type of cover, and water temperature (Reviewed in Nakamoto 1994; Nielsen 1994; Baigun *et al*. 2000). Only winter steelhead are found in the CCC steelhead ESU, whereas both winter and summer steelhead are found in the NC steelhead ESU.

Busby *et al*. (1996) and Fukushima and Lesh (1998) document immigration timing for winter and summer steelhead throughout the action area. Typically, adult winter steelhead immigrate from September through June, while adult summer steelhead immigrate from March through September. Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. The minimum stream depth necessary for successful upstream migration is 13 cm (Thompson 1972). The preferred water velocity for upstream migration is in the range of 40-90 cm/s, with a maximum velocity, beyond which upstream migration is not likely to occur, of 240 cm/s (Thompson 1972; Smith 1973).

Most spawning takes place from January through April. Steelhead may spawn more than one season before dying (iteroparity), in contrast to other species of the *Oncorhynchus* genus. Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams. Among repeat spawners, the representation of each group declines as the number of spawnings increases. There is a sharp decline in numbers from second spawners (15.0 percent) to third spawners (2.1 percent). Fish spawning four or more times are rare (0.1 percent). Steelhead usually spawn in the tributaries where fish ascend as high as flows permit (United States Army Corps of Engineers 1982).

Because rearing juvenile steelhead reside in freshwater all year, adequate flow and temperature are important to the population at all times (CDFG 1997). Generally, throughout their range in California, steelhead that are successful in surviving to adulthood spend at least two years in freshwater before emigrating downstream. Emigration appears to be more closely associated with size than age. In Waddell Creek, Shapovalov and Taft (1954) found steelhead juveniles migrating downstream at all times of the year with the largest numbers of age 0+ and yearling steelhead moving downstream during spring and summer. Smolts can range from 14-21 cm in length.

Steelhead spawn in cool, clear streams featuring suitable water depth, gravel size, and current velocity. Intermittent streams may be used for spawning (Everest 1973; Barnhart 1986). Reiser and Bjornn (1979) found that gravels of 1.3-11.7 cm in diameter and flows of approximately 4 cfs were preferred by steelhead. The survival of embryos is reduced when fines of less than 6.4 mm comprise 20-25 percent of the substrate. Studies have shown a higher survival of embryos when intragravel velocities exceed 20 cm/hr (Coble 1961; Phillips and Campbell 1961). The number of days required for steelhead eggs to hatch is inversely proportional to water temperature and varies from about 19 days at 15.6ºC to about 80 days at 5.6ºC. Fry typically emerge from the gravel two to three weeks after hatching (Barnhart 1986).

Upon emerging from the gravel, fry rear in edgewater habitats and move gradually into pools and riffles as they grow larger. Older fry establish territories which they defend. Cover is an important habitat component for juvenile steelhead both as velocity refuge and as a means of avoiding predation (Shirvell 1990; Meehan and Bjornn 1991). Steelhead however, tend to use riffles and other habitats not strongly associated with cover during summer rearing more than other salmonids. Young steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles. In winter, they become inactive and hide in any available cover, including gravel or woody debris.

Water temperature influences the growth rate, population density, swimming ability, ability to capture and metabolize food, and ability to withstand disease of these rearing juveniles (Barnhart 1986; Bjornn and Reiser 1991). Rearing steelhead juveniles prefer water temperatures of 7.2-14.4ºC and have an upper lethal limit of 23.9ºC. They can survive up to 27EC with saturated dissolved oxygen conditions and a plentiful food supply. Fluctuating diurnal water temperatures also aid in survivability of salmonids (Busby *et al.* 1996).

Dissolved oxygen (DO) levels of 6.5-7.0 mg/l affected the migration and swimming performance of steelhead juveniles at all temperatures (Davis *et al.* 1963). Reiser and Bjornn (1979) recommended that DO concentrations remain at or near saturation levels with temporary reductions no lower than 5.0 mg/l for successful rearing of juvenile steelhead. Low DO levels decrease the rate of metabolism, swimming speed, growth rate, food consumption rate, efficiency of food utilization, behavior, and ultimately the survival of the juveniles.

During rearing, suspended and deposited fine sediments can directly affect salmonids by abrading and clogging gills, and indirectly cause reduced feeding, avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat (Reiser and Bjornn 1979). Bell (1973) found that silt loads of less than 25 mg/l permit good rearing conditions for juvenile salmonids.

IV. ENVIRONMENTAL BASELINE

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat, and the ecosystem in the action area. The environmental baseline includes the past and present impacts of all federal, state, or private actions and other human activities in the action area (50 CFR §402.02).

The action area includes all coastal California streams from Aptos Creek in Santa Cruz County north to the Oregon/California border and all streams draining into San Francisco and San Pablo bays eastward to the Napa River (inclusive), excluding the Sacramento-San Joaquin River Basin (Figure 1).

This area encompasses approximately 20,900 square miles of the Northern California Coast Range. Native vegetation varies from old growth redwood (*Sequoia sempervirens*) forest along the lower drainages to Douglas-fir (*Pseudotsuga menziesii*) intermixed with hardwoods, to ponderosa pine (*Pinus ponderosa*) and Jeffery pine (*Pinus jefferyi*) stands along the upper elevations. Areas of grasslands are also found along the main ridge tops and south facing slopes of the watersheds.

The action area has a Mediterranean climate characterized by cool wet winters with typically high runoff, and dry warm summers characterized by greatly reduced instream flows. Fog is a dominant climatic feature along the coast, generally occurring daily in the summer and not infrequently throughout the year. Higher elevations and inland areas, however, tend to be relatively fog free. Most precipitation falls during the winter and early spring as rain with occasional snow above 1,600 feet. The action area receives one of the highest annual amounts of rainfall in California with a few sections averaging over 85 inches a year. The range of the mean rainfall is from 9 to 125 inches (Figure 3). Extreme rain events do occur, with over 240 inches being recorded over parts of the action area during 1982-83. Along the coast, average air temperatures range from 46E to 56E F. Further inland and in the southern part of the action area, annual air temperatures are much more varied, ranging from below freezing in winter to over 100E F during the summer months.

High seasonal rainfall on bedrock and other geologic units with relatively low permeability, erodible soils, and steep slopes contribute to the very flashy nature of the watersheds within the action area. In addition, this high natural runoff rate has been increased by extensive road systems and other land uses. High seasonal rainfall combined with a rapid runoff rate on unstable soils delivers large amounts of sediments to the river systems. As a result, many river systems within the action area contain a relatively large sediment load which is typically deposited throughout the lower gradient reaches of these systems.

A. Status of the Species Within the Action Area

The action area includes the entire ESUs for CCC coho salmon, CC Chinook salmon, NC steelhead, and CCC steelhead; however, the action area includes only the portion of the SONCC coho salmon ESU within California. Approximately 70 percent of the SONCC coho salmon ESU is within the action area. For the ESUs contained wholly within the action area, the rangewide status of the species is described within the preceding section of this opinion. Following is a discussion of the status of SONCC coho salmon within the action area.

No regular escapement estimates exist for natural spawning in California streams. Most available information for the California portion of this ESU was summarized by CDFG (1994). They concluded that coho salmon in California, including hatchery stocks, could be less than 6 percent of their abundance during the 1940s, and have experienced at least a 70 percent decline in numbers since the 1960s (CDFG 1994, p. 5-6). They also reported that coho salmon populations have been virtually eliminated in many streams, and that adults are observed only every third year in some streams, suggesting that two of three brood cycles may already have been eliminated. Brown and Moyle (1991) estimated that naturally-spawned adult coho salmon returning to California streams were less than one percent of their abundance at mid-century, and indigenous, wild coho salmon populations in California did not exceed 100 to 1,300 individuals. Further, they stated that 46 percent of California streams which historically supported coho salmon populations, and for which recent data were available, no longer supported runs. The Klamath River Basin (including the Trinity River) historically supported abundant coho salmon runs. In both systems, runs have been greatly diminished and are now composed largely of hatchery fish, although there may be small wild runs remaining in some tributaries (CDFG 1994). Of 396 streams within this ESU identified as once having coho salmon runs, Brown *et al.* (1994) were able to find recent survey information on 115 (30%) (Table 3). Of these 115 streams, 73 (64%) still supported coho salmon runs while 42 (36%) did not. The streams identified as presently lacking coho salmon runs were all tributaries of the Klamath and Eel River systems. The rivers and tributaries in the California portion of this ESU were estimated to have average recent runs of 7,080 natural spawners and 17,156 hatchery returns, with 4,480 identified as native fish occurring in tributaries having little history of supplementation with non-native fish (Brown *et al.* 1994). Other assessments of stocks within this ESU have identified several stocks as being at risk or of concern. In this region of California, Nehlson *et al.* (1991) identified coho salmon in the Klamath River as a run of special concern, and those in small northern streams as at moderate risk of extinction. Higgins *et al.* (1992) identified 10 coho salmon stocks of special concern, and 6 as at high risk of extinction. Although NOAA Fisheries (2001a) found few data to describe current trends, available data suggests that SONCC coho salmon continue to decline in abundance.

B. Factors Affecting the Environment Within the Action Area

Many of the biological requirements for anadromous salmonids in the action area can best be expressed in terms of the essential features of their habitat. That is, they require adequate: (1) substrate (especially spawning gravel), (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) migration conditions. The best scientific information presently available demonstrates that a multitude of factors, past and present, have contributed to the decline of west coast salmonids by adversely affecting these essential habitat features.

NOAA Fisheries cites many reasons (primarily anthropogenic) for the decline of CCC and SONCC coho salmon (Weitkamp *et al*. 1995), CC Chinook salmon (Myers *et al*. 1998), and NC and CCC steelhead (Busby *et al*. 1996). The foremost reason for the decline in these anadromous salmonid populations is the degradation and/or destruction of habitat. Additional factors contributing to the decline of these populations include: commercial and recreational harvest, ocean conditions, predation, natural stochastic events, and water quality. Scientific research and habitat restoration activities may affect anadromous salmonid populations within the action area, but have not been specifically identified as factors contributing to the decline of these populations.

The following section details the probable causes of the decline of the SONCC coho salmon, CCC coho salmon, CCC steelhead, NC steelhead, and CC Chinook salmon ESUs. The extent to which there are species specific differences in population limiting factors is not clear; however, the freshwater ecosystem characteristics necessary for the maintenance of self-sustaining populations of anadromous salmonids throughout the action area are similar.

1. <u>Agriculture</u>

Agricultural practices have contributed to the degradation of salmonid habitat on the West Coast through irrigation diversions, overgrazing in riparian areas, and compaction of soils in upland areas from livestock (reviewed in 61 FR 56138.) These practices have also altered the natural flow patterns of streams and rivers within the action area. Early agricultural practices have resulted in filled sloughs and side channels and removed riparian vegetation. River valleys have been leveled and water courses channelized, altering drainage and runoff patterns. Agricultural operations removed riparian vegetation, small in-channel islands, and gravel bars to increase arable acreage and achieve flood control.

Vegetation removal and channel destabilization has accelerated erosion. In response to increased erosion, bank stabilization measures began and continued as cultivated acreage increased. Stabilization measures increased channel straightening which expedited channel downcutting. In addition to changing river morphology, agricultural practices decrease water quality by releasing fertilizers and pesticides into streams and rivers (Florsheim and Goodwin 1993). Enrichment from manures is also a problem where barns and livestock are adjacent to watercourses. Maahs *et al.* (1984) reported that the largest diffuse source of water quality degradation comes from agriculture-derived contaminants such as sediment, nutrients and pesticides (reported in Osborne and Kovacic (1993)).

Grazing activities within the action area have resulted in loss of native perennial grasses and riparian vegetation; soil loss; hillside trailing and gullying; and the incision of swales and meadows. Soils compacted by overgrazing on land with minimal vegetative cover have significantly reduced infiltration rates. Instead of the water moving into the soil it moves rapidly over it, delivering heavy runoff to streams, which in turn can result in flashy watersheds (Kohler and Hubert 1993). This altered cycle is characterized by reduced groundwater storage capacity, and a greater propensity for intermittent stream flow during low flow periods. The response within the stream corridor is one of bank erosion, channel scour, and loss of riparian and fish habitat.

The vigor, composition and diversity of natural vegetation can be altered by livestock grazing in and around riparian areas. This in turn can affect the site's ability to control erosion, provide stability to stream banks, and provide shade, cover, and nutrients to the stream. Mechanical compaction can reduce the productivity of the soils appreciably and cause bank slough and erosion. Mechanical bank damage often leads to channel widening, lateral stream migration, and excess sedimentation. Reviewed in (61 FR 56138).

2. <u>Forestry</u>

Forestry practices have limited production of anadromous salmonids and affected their habitat in many ways. Habitat degradation by forestry activities has mostly occurred in tributaries, which mostly affects spawning and early-rearing juvenile salmonids. Populations are limited in tributary and mainstem habitats by the loss of large woody debris, debris barriers, increased temperatures, massive siltation, loss of riparian cover diversity, road building and maintenance causing increased sedimentation of fines and the filling of pools. Bilby and Bisson 1998 (as reported in Standiford and Arcilla 2001) stated that large woody debris in Northern California streams has generally decreased over the last century due to forestry practices. The loss of large woody debris affects fish in that there is less habitat complexity, less deposition of sediment, less deposition of fine organic matter that feeds stream invertebrates, and fewer pool forming elements.

Forestry practices have also affected salmonid habitat by the removal of streamside vegetation, accelerating erosion, the introduction and removal of organic debris, and altering the shape of the channel (Chamberlin 1982). The removal of riparian vegetation along the channel from logging activities can result in increased stream temperatures (Beschta *et al.* 1987). These temperature changes can impact salmonids by influencing factors such as rates of egg development, rearing success and species competition and increase their susceptibility to diseases. Increased erosion can occur as a result of forestry activities. Site disturbance and road construction typically increase sediment delivery to streams through mass wasting and surface erosion, which can elevate levels of fine sediment in spawning gravels and fill pool habitats used by salmonids for rearing (Spence *et al*. 1996).

The affects of introducing organic debris can be positive in that organic debris controls sediment transport and provides habitat for aquatic organisms (Swanson and Lienkaemper 1978, Keller and Swanson 1979, Bryant 1980), however, the introduction of excessive amounts can impede fish movement and reduce dissolved oxygen levels (Hall and Lantz 1969). Logging activities can also lead to morphological changes in the channel due to increased sediment inputs (Reid

1994). These changes include the widening and increased braiding of some streams and the filling in of pools. When flows on these streams spread too widely, upstream migration of adults is hindered. The loss of pools decreases available habitat for salmonids and removes cool water refuges needed for summer survival in some streams.

Timber harvest related activities in the past have had more impact across forested ecosystems than current timber practices, especially those that employed ground-based equipment methods just after World War II. The majority of private and state timber land holdings within the action area have been harvested, leading to a decrease in habitat quality for salmonids. Also, the removal of riparian trees during timber harvesting activities reduces shading and recruitment of organic debris important in maintaining salmonid habitats (Spence *et al.* 1996). Past timber harvest and to some extent ongoing timber harvest activities along many streams within the action area have contributed to decreases in wild populations of anadromous salmonids over time.

3. <u>Urban Development</u>

Urbanization has degraded anadromous salmonid habitat through stream channelization, flood plain drainage, and riparian damage (reviewed in 61 FR 56138). When watersheds are urbanized, problems may result simply because structures are placed in the path of natural runoff processes, or because the urbanization itself has induced changes in the hydrologic regime. In almost every point that urbanization activity touches the watershed, point source and nonpoint pollution occurs. Sources of nonpoint pollution, such as sediments washed from the urban areas, contain trace metals such as copper, cadmium, zinc, and lead (California State Lands Commission 1993). These, together with pesticides, herbicides, fertilizers, gasoline, and other petroleum products, contaminate drainage waters and harm aquatic life necessary for anadromous salmonid survival. Water infiltration is reduced due to extensive ground covering. As a result, runoff from the watershed is flashier, with increased flood hazard (Leopold 1968). Flood control and land drainage schemes may concentrate runoff, resulting in increased bank erosion which causes a loss of riparian vegetation and undercut banks and eventually causes widening and down-cutting of the stream channel.

Florsheim and Goodwin (1993) found that as urban centers develop, there was an initial influx of sediment into streams from erosion, followed by an increase in runoff from the large areas of concrete and asphalt once building is complete. This resulted in increased flooding and stream bank erosion, to which the frequent human response was stream channelization, particularly on tributaries. SEC (1996) was concerned that roads may pose the greatest threat of urbanization to streams. They concluded that road construction and unpaved roads caused significant direct sediment input to streams, i.e., poorly designed road cuts and inadequate grading maintenance frequently resulted in hillslope failure.

As human population expanded, demand for gravel and water increased proportionately, resulting in altered stream channels and degraded habitat, either directly or through cumulative negative impacts to the river system (SEC 1996). Florsheim and Goodwin (1993) determined that stream pollution increased with higher human density, degrading water quality for both people and wildlife. Increased water demands and unscreened diversions threaten newly emerged fry (SEC 1996).

Roads, bridges, and residential development located in flood plains have historically been supported by an ongoing process of channel maintenance to protect the existing infrastructure. These channel maintenance activities include removal of large woody debris, armoring of stream banks with rip-rap, construction of gabions and engineered bank stabilization structures, diking and rechanneling of natural stream channels. Although many of these activities have been scaled back or curtailed in recent years, the effects of these activities are still influencing salmonid populations within the basin.

Urbanization has been a major influence on the land surrounding the San Francisco Bay Estuary. In the past 150 years, the diking and filling of tidal marshes have decreased the surface area of San Francisco Bay by 37 percent. More than 500,000 acres of the estuary's historic tidal wetlands have been converted to farms, salt ponds, and urban uses. Today, nearly 30 percent of the land in the nine counties surrounding San Francisco Bay is urbanized. The increase in urban land reflects the growth of the human population. There are now more than 7.5 million individuals living in the 12 Bay Area counties, making the region the fourth most populous metropolitan area in the United States. These changes have reduced the acreage of valuable farm land, wetlands, and riparian areas, and have increased pollutant loadings to the estuary. Installation of docks, shipping wharves, marinas, and miles of rock rip rap for shoreline protection has also contributed greatly to habitat degradation within the estuary.

Channel manipulations for flood control, bank stabilization, and gravel extraction have reduced the amount of valuable riffle habitat for rearing juvenile salmonids throughout the action area.

4. Water Quality

Many waterways in the action area fail to meet the Federal Clean Water Act and Federal Safe Drinking Water Act water quality standards due to the presence of pesticides, heavy metals, dioxins and other pollutants. These pollutants originate from both point- (industrial and municipal waste) and nonpoint (agriculture, forestry, urban activities, etc.) sources. The types and amounts of compounds found in runoff are often correlated with land use patterns: fertilizers and pesticides are found frequently in agricultural and urban settings, and nutrients are found in areas with human and animal waste. People contribute to chemical pollution in the area, but natural and seasonal factors also influence pollution levels in various ways. Nutrient and pesticide concentrations vary considerably from season to season, as well as among regions with different geographic and hydrological conditions. Natural features (such as geology and soils) and land-management practices (such as storm water drains, tile drainage and irrigation) can influence the movement of chemicals over both land and water. Salmon require clean water and gravel for successful spawning, egg incubation, and fry emergence. Fine sediments clog the spaces between gravel and restrict the flow of oxygen-rich water to the incubating eggs. Pollutants, excess nutrients, low levels of dissolved oxygen, heavy metals, and changes in pH also directly affect the water quality for salmon and steelhead.

Return water from irrigated fields can introduce nutrients and pesticides into streams and rivers. Sediments washed from the urban areas contain trace metals such as copper, cadmium, zinc, and lead (California State Lands Commission 1993). These, together with pesticides, herbicides, fertilizers, gasoline, and other petroleum products, contaminate drainage waters and harm aquatic life necessary for anadromous salmonid survival. (The previous paragraph extracted from (61 FR 56138)).

5. Altered Flow Patterns

Instream flows within the action area are strongly influenced by land-use practices, water diversion, and seasonal weather patterns. Loss of native perennial vegetation, soil compaction, and hillside trailing by livestock has produced an abbreviated hydrologic cycle within a significant portion of the streams within the action area. This altered cycle is characterized by higher peak flows during storm events; a rapid decline in flows during the spring; and a greater propensity for intermittent stream flow during low flow periods (R. Smith, United States Forest Service, pers comm.).

In some of the larger river systems, regulated flows from mainstem dams has increased summer stream flow eliminating thermal stratification of pools, and have led to a shift in the fish community to warmwater fish species. Flow and temperature conditions now favor warmwater species in many of these mainstem systems and have compromised salmonid rearing and migration. Regulated flows also enable agricultural and urban development within these watersheds which has resulted in further impacts to salmonids in the form of increased runoff to streams, increased sedimentation, channelized tributaries, impacts to riparian vegetation, and decreases in stream flow (Spence *et al*. 1996).

Intermittent stream flows within the action area are a significant problem for rearing juvenile salmonids. Many smaller streams within the action area experience seasonal dewatering to a certain degree. When these seasonal intermittent flows occur, juvenile salmonids are trapped in isolated pools. Survival of these fish is relatively low and mortality has been reported in some studies to be as high as 47 percent for coho salmon and 82 percent for steelhead in some of these streams (R. Smith, United States Forest Service, pers comm.). Mortality most often results from the effects of poor water quality, predation, reduced forage sources, and/or dessication of habitat. In one study (R. Smith, United States Forest Service, pers comm.), it was estimated that this mortality alone accounted for approximately 33 percent of the total estimated juvenile coho salmon population in Olema Creek, California, during 1999.

Within the action area, water is diverted for urban, commercial, agricultural, and residential use. In addition to a number of large reservoirs in the action area, there are an unknown number of permanent and temporary water withdrawal facilities that divert water for similar purposes. Impacts from water withdrawals include localized dewatering of stream reaches, entrapment of younger salmonids, and depletion of flows necessary for migration, spawning, rearing, flushing of sediment from spawning gravels, gravel recruitment, and transport of large woody debris. Unprotected or poorly screened water diversions can also impact young salmonids; young fry are easily drawn into water pumps or become stuck against the pump's screened intakes. Unscreened or inadequately screened diversions are common throughout the action area.

Water withdrawals (primarily for irrigation) have reduced summer flows in nearly every stream in the action area and thereby profoundly decreased the amount and quality of salmonid rearing habitat. Water quantity problems are a significant cause of habitat degradation and reduced fish production. A significant proportion of the action area is irrigated. Although some of the water withdrawn from streams eventually returns as agricultural runoff or groundwater recharge, crops consume a large proportion of it. Withdrawals affect seasonal flow patterns by removing water from streams in the summer (mostly May through September) and restoring it to surface streams and groundwater in ways that are difficult to measure. Withdrawing water for irrigation, urban consumption, and other uses increases temperatures, smolt travel time, and sedimentation.

6. Gravel Mining

Gravel mining is a major cause of sediment deficit in watersheds within the action area. In-channel mining removes gravel by either skimming it from bars or excavating it directly from the channel. Over-harvesting of gravel can lead to river incision, bank erosion, habitat simplification, and tributary downcutting (SEC 1996).

Gravel mining has resulted in morphological changes to many river systems within the action area. Decreased sediment load has caused these rivers to increase in depth, resulting in extensive bank erosion (Florsheim and Goodwin 1993). Degradation or downcutting of the channel due to past mining in the middle reaches of some rivers has also lead to impacts on adjacent ground water tables.

Loss of spawning gravels has a direct impact on salmonids within the action area. Female salmon choose spawning sites where there is clean, loosely compacted gravel or cobble substrates with less than 20 percent fine silt or sand content, and an intergravel flow sufficient to aerate the eggs. The lack of suitable gravel often limits successful spawning in many streams.

Turbidity as a result of increased erosion and sedimentation caused by gravel mining can also be a limiting factor for anadromous salmonid populations. Salmonids are particularly sensitive to turbidity (Bjornn and Reiser 1991); it may lead to failed spawning, reduced respiratory efficiency, interruption of migration, altered prey base, reduced visibility, and reduction in plant production. Reduced plant production may, in turn, lead to lower dissolved oxygen levels and diminished food and cover for fish and aquatic insects.

7. Dams

Dams have a wide variety of functions including hydropower production, residential, commercial, and agricultural water supply; and flood and/or debris control. The development of dams in the rivers in the action area (Figure 4) has dramatically affected anadromous salmonids utilizing these streams. Dams have eliminated spawning and rearing habitat and altered the natural hydrograph of most of the major river systems within the action area, decreasing spring and summer flows and increasing fall and winter flows. Channel narrowing can occur as the riparian zone becomes overgrown with vegetation that would otherwise have been scoured by frequent but moderate flows (Kondolf 1997). Dams cause flow levels and river elevations to fluctuate, slowing fish movement through reservoirs, altering riparian ecology, and stranding fish in shallow areas. The numerous dams within the action area alter salmonid migrations and may kill smolts and adults. Dams have also converted the once-swift riverine environment into a series of slow-moving reservoirs, slowing the smolts' journey to the ocean and creating habitat for predators.

The construction of dams on rivers creates impassable barriers to salmon migration and alters the transportation of sediment through the stream system. The inability to access tributary habitat areas limits anadromous salmonid populations throughout the action area. Large mainstem dams on major rivers as well as smaller dams on tributaries degrade or block access to the most important salmonid spawning and rearing habitat. These dams not only interfere with the upstream migration of salmon and steelhead, but also reduce the highest flows that would occur without them, thus inhibiting the ability of the stream to flush out the system and move sediment through the stream channel.

Dams block the movement of sediments, limiting the recruitment of necessary spawning gravel downstream. Sediment above the dam is prevented from moving downstream, and sediment transport below the dam is changed. Channel characteristics, including the configuration and character of pools, riffles, and glides, are altered. Florsheim and Goodwin (1993) found that decreased downstream sediment transport caused a myriad of morphological problems, including increased river depth, which resulted in extensive bank erosion. In addition, tributary dams and domestic or agricultural water diversions reduce downstream flows and increase water temperatures (Prolysts 1984). SEC (1996) reported that according to the United States Army Corps of Engineers (1982), the loss of tributary habitat was the primary factor limiting the recovery of the anadromous fishery in the Russian River basin.

Dams used for flood control have led to channel erosion, accompanied by an increase in particle size of the bed material. Since salmonids use freshwater gravels to incubate their eggs, the presence of the larger cobbles and boulders can threaten their spawning success (Kondolf 1997).

8. <u>Commercial and Recreational Harvest</u>
Historically, salmon and steelhead were abundant in coastal and interior streams of the action area and have supported substantial tribal, sport, and commercial fisheries - contributing millions of dollars to numerous local economies. Over-fishing in the early days of the European settlement led to the depletion of many stocks of salmon and steelhead even before extensive habitat degradation. More recently, overfishing in nontribal fisheries is believed to have been a significant factor in the decline of salmon and steelhead. This included significant overfishing that occurred from the time marine survival turned poor for many stocks (ca. 1976) until the mid-1990s when harvest was substantially curtailed. Since 1994, the retention of coho salmon has been prohibited in marine fisheries south of Cape Falcon, Oregon. Coho salmon are still impacted, however, as a result of hook-and-release mortality in Chinook salmon-directed fisheries. Sport and commercial fishing restrictions ranging from severe curtailment to complete closures in recent years may be providing an increase in adult salmon and steelhead spawners in some streams, but trends cannot be established from the existing data.

It is unclear to what extent commercial and recreational harvest has played a role in the decline of CCC coho salmon, CCC steelhead and CC Chinook. There is currently a significant lack of biological data for CC Chinook. There are no reliable estimates of ocean harvest rates for California coastal Chinook and there is uncertainty regarding the abundance trends of these stocks. This makes it a challenge to determine whether these stocks can recover under the current levels of fish mortality. The limited spawning data that does exist suggest that spawner abundance of some California coastal Chinook populations may have improved since 1996, when ocean harvest constraints were introduced to protect Sacramento River winter-run Chinook (NOAA Fisheries 2001b). Anderson (1995) noted that there was considerable disagreement as to the role that commercial and recreational ocean fishing had played in the long term decline of coho salmon populations. He found that this disagreement continued even though there were few historical or recent records to indicate that curtailment of fishing had increased coho salmon spawner abundance. There are few good historical accounts of the abundance of coho salmon harvested along the California coast (Jensen and Swartzell 1967). Early records did not contain quantitative data by species until the early 1950s. Anderson (1995) reported that annual catch of coho salmon in California's commercial troll fishery ranged from 100,000 to more than 650,000 fish in the early 1960s and 1970s, but had declined to an average of 54,300 fish (including a mixture of wild and hatchery fish) during the period 1980-1990.

Although currently no coho salmon may be legally retained in either marine or freshwater in California, CDFG port samplers routinely observe coho salmon retained from the ocean by recreational fisherman who either did not know the regulations or were not able to discern coho salmon from Chinook salmon. It is unlikely that steelhead were affected by ocean commercial or recreational fisheries, but freshwater recreational fishing for steelhead is a popular activity and may have intermittently reduced spawner abundance. However, coho salmon and steelhead populations have not rebounded since commercial and recreational fisheries have been curtailed to protect them.

Additionally, there are incidental mortalities of coho salmon due to stress when captured and released by fisherman targeting other marine fish species. The confounding effects of habitat deterioration, drought, and poor ocean conditions on coho salmon survival make it difficult to assess the degree to which recreational and commercial harvest have contributed to the overall decline of coho salmon in west coast rivers.

9. Hatcheries

Out of basin sources of broodstocks have been introduced in hatcheries and widely transplanted in many coastal rivers and streams throughout central California (Bryant 1994; Weitkamp *et al*. 1995). The use of state-funded fish hatcheries in California dates back to 1870. Since their inception, the purpose of these facilities has been "to stock and supply streams, lakes, bays with both foreign and domestic fish" (Leitritz 1970). The intent of stocking has been to provide fish for sport and commercial fishing, for restoration, and for mitigation. To these ends, hatcheries have provided the state's citizens with untold millions of sport and commercial fish, predominantly salmon and trout.

A number of risks to wild populations of salmon can result from hatchery operations. Ecologically, hatchery fish can predate on and compete with wild fish. These effects are most likely to occur when fish are released in poor condition and do not migrate to marine waters, but rather remain in the streams for extended rearing periods. Hatchery fish also may transmit hatchery-borne diseases to relatively healthy populations of wild fish, and hatcheries themselves may release disease-carrying effluent into streams.

Consensus is forming that hatchery supplementation has resulted in major negative impacts to salmonids including loss of genetic diversity, displacement of native stocks, and disease transfer

(Nehlson *et al.* 1991; Higgins *et al.* 1992; Cramer *et al.* 1995). The loss of genetic diversity through selective breeding, inbreeding and interbreeding concerns many fish biologists as this can compromise the ability of both wild and hatchery fish to adapt to environmental change (Weitkamp *et al.* 1995). Selective breeding for individual characteristics such as large size or early run timing can diminish a hatchery stock's genetic variability. Weitkamp *et al*. (1995) note hatcheries tend to select their spawners from earlier portions of the run, leading to advanced and compressed run timing. (The previous paragraph was extracted from SEC (1996)).

Hatchery stocks are generally less fit for survival in streams than wild fish (Hillborn 1992). Hatchery stocks are adapted to hatchery conditions and are often less successful at locating spawning gravels, avoiding predators, or finding natural food. Negative impacts of hatchery rearing are not limited to one generation; studies have consistently found the progeny of hatchery fish have a considerably lower survival rate than those of wild fish (Smith *et al*. 1985). Cramer *et al*. (1995) state that hatchery practices have led to a lack of genetic fitness on the North Coast. (The previous paragraph extracted from SEC (1996)).

10. <u>Ocean Conditions</u>

Variability in ocean productivity has been shown to affect salmon production both positively and negatively. Beamish and Bouillion (1993) showed a strong correlation between North Pacific salmon production from 1925 to 1989 and their marine environment. Beamish *et al.* (1997) noted decadel-scale changes in the production of Fraser River sockeye salmon that they attributed to changes in the productivity of the marine environment. They (along with many others) also reported the dramatic change in marine conditions occurring in 1976-77, whereby an oceanic warming trend began. El Niño conditions, which occur every 3-5 years, negatively affect ocean productivity. Johnson (1988) noted increased adult mortality and decreased average size for Oregon's Chinook and coho salmon during the strong 1982-83 El Niño. It is unclear to what extent ocean conditions have played a role in the decline of anadromous salmonids within the action area however, ocean conditions have likely affected populations throughout their evolutionary history. (The previous paragraph was extracted from (61 FR 56138)).

SEC (1996) noted that changes in oceanic conditions along the North American Pacific Coast over the past 60 years may be significantly contributing to the decline of California coho salmon populations. A warming trend in sea temperatures along the coast is causing dramatic declines in zooplankton abundance, corresponding declines in fish species that forage on zooplankton, changes in ocean current and upwelling patterns, a northward shift in many marine species population ranges, an overall decline in ocean productivity, and an oceanic environment becoming far less favorable for coho salmon survival (SEC 1996). Brown *et al*. (1994) summarize evidence suggesting that major ocean mortality of smolt and adult coho salmon has been occurring at least over the past 20 years.

An environmental condition often cited as a cause for the decline of west coast salmonids is the condition known as ''El Ni½o". El Ni½o is a warming of the Pacific Ocean off South America and is caused by atmospheric changes in the tropical Pacific Ocean. During an El Ni½o event, a plume of warm sea water flows from west to east toward South America, eventually reaching the coast where it is reflected south and north along the continents. El Ni½o ocean conditions are characterized by anomalously warm sea surface temperature and changes in thermal structure, coastal currents, and upwelling. Principal ecosystem alterations include decreases in primary and secondary productivity and changes in prey and predator species distributions. Several El Ni½o events have been recorded during the last several decades, including those of 1940–41, 1957–58, 1982–83, 1986–87, 1991–92, 1993–94, and 1997-98. The degree to which adverse ocean conditions can influence coho salmon production was demonstrated during the El Ni½o event of 1982–83, which resulted in a 24 to 27 percent reduction in fecundity and a 58 percent reduction (based on pre-return predictions) in survival of adult coho salmon stocks originating from the Oregon Production Index area (Johnson 1988). (The previous paragraph extracted from (61 FR 56138)).

11. Predation

Freshwater predation by other salmonids is not believed to be a major factor contributing to the decline of central California coho salmon. Avian predators have been shown to impact some juvenile salmonids in fresh water and near shore environments. Ring-billed gulls (*Larus delawarensis*) consumed a small percent of the salmon and steelhead trout passing Wanapum Dam, in the Columbia River, during the spring smolt outmigration in 1982. Common mergansers (*Mergus merganser*), freshwater predators of juvenile salmonids, were able to consume 24 to 65 percent of coho salmon production in coastal British Columbia streams. Herons, cormorants, and alcids are known to prey on salmonids in the near shore marine environment. Marine mammal and avian predation may occur on some local salmonid populations; however, it is a minor factor in the decline of coastwide salmonid populations (Reviewed in 61 FR 56138).

With the decrease in quality riverine and estuarine habitats, increased predation by freshwater, avian, and marine predators will occur. With the decrease in avoidance habitat (e.g., deep pools and estuaries, and undercut banks) and adequate migration and rearing flows, predation may play a small role in the reduction of some localized coho salmon stocks. Harbor seal and California sea lion numbers have increased along the Pacific Coast. At the mouth of the Russian River, Hanson (1993) reported that the foraging behavior of California sea lions and harbor seals with respect to anadromous salmonids was minimal. Hanson (1993) also stated that predation on salmonids appeared to be coincidental with the salmonid migrations rather than dependent upon them. Principal food sources of marine mammals include small pelagic schooling fish, juvenile rockfish, lampreys, and benthic and epibenthic species; salmonids make up a minor component of the diet (reviewed in 61 FR 56138).

Several studies have indicated that piscivorous predators may control the abundance and survival of salmonids. Holtby *et al*. (1990) hypothesized that temperature-mediated arrival and predation by Pacific hake may be an important source of mortality for coho salmon off the west coast of Vancouver island. Pearcy (1992) reviewed several studies of salmonids off the Pacific Northwest coastline and concluded that salmonid survival was influenced by the factional responses of the predators to salmonids and alternative prey. (The previous paragraph extracted from (61 FR 56138)).

The relative impacts of marine predation on anadromous salmonids are not well understood, but most investigators believe that marine predation is a minor factor in coho salmon declines. Predators play an important role in the ecosystem, culling out unfit individuals, thereby strengthening the species as a whole. The increased impact of certain predators has been to a large degree the result of ecosystem modification. Therefore, it would seem more likely that increased predation is but a symptom of a much larger problem, namely, habitat modification and a decrease in water quantity and quality. (The previous paragraph extracted from (61 FR 56138)). Chinook salmon may be impacted by ocean predation though the levels of predation are largely unknown (NOAA Fisheries 2001b).

Both coho salmon and steelhead have evolved with a host of predators that prey upon them and it is doubtful whether predation has increased to any extent since the time when populations were robust. Thus, it is unclear what role predation has played in influencing the present depressed status of CCC coho salmon and CCC steelhead; however, given their status today, predators may retard restoration or further exacerbate anthropogenic impacts. For example, diversion of stream flow for irrigation may affect the opening of sandbars at the mouths of creeks thereby altering the timing of adult spawning migrations and disposing fish to higher levels of marine mammal predation. It is unclear to what extent predation is occurring, however NOAA Fisheries (1997b) reported discussions with Dave Streig and Matt McCaslin of the Monterey Bay Salmon and Trout Project who noted that on the San Lorenzo River 15 percent of the returning steelhead had pinniped bite and claw marks in the 1991 season, increasing to 47 percent and 54 percent in the 1994 and 1995 seasons. Similar proportions on coho salmon (28-40 percent) and steelhead (31-50 percent) were observed from 1994 and 1995 in nearby Scott Creek.

12. <u>Natural Stochastic Events</u>

Natural events such as floods, droughts, landslides, and other catastrophes have adversely affected anadromous salmonid populations throughout their evolutionary history and yet they have survived. The effects of these events are oftentimes exacerbated by anthropogenic changes to watersheds such as logging, road building, and water diversion. Additionally, the ability of species to rebound from natural stochastic events may be limited as a result of other existing anthropogenic factors or depressed populations.

Coho salmon have been adversely impacted by catastrophic natural events over their evolutionary history in California and have survived to recolonize streams and reestablish populations. Unfortunately, their resiliency as a species, to rebound in time from floods, droughts, landslides and other natural stochastic events, is now negated by the pervasive destruction and degradation of their essential stream habitats, and reduction in population size below the numbers necessary to insure their present survival against natural environmental disasters (Brown *et al*. 1994).

Floods can destroy or alter stream and lagoon habitats, accelerate erosion and sedimentation, and decimate eggs, fry and juvenile salmon populations, thus reducing or eliminating year classes (Anderson 1995). As previously mentioned, sedimentation of stream beds has been implicated as a principal cause of declining salmonid populations throughout their range. Floods can result in mass wasting of erodible hill slopes and failure of roads on unstable slopes causing catastrophic erosion. In addition, flooding can cause scour and redeposition of spawning gravels in typically inaccessible areas.

During flood events, land disturbances resulting from logging, road construction, mining, urbanization, livestock grazing, agriculture, fire, and other uses may contribute sediment directly to streams or exacerbate sedimentation from natural erosive processes (California Advisory Committee on Salmon and Steelhead Trout 1988; California State Lands Commission 1993; Forest Ecosystem Management Assessment Team 1993). The California State Lands Commission (1993) has stated that northwestern California is an area which consists of easily erodible rock. As streams and pools fill in with sediment, flood flow capacity is reduced. Such changes cause decreased stream stability and increased bank erosion, and subsequently exacerbate existing sedimentation problems (Lisle 1982), including sedimentation of spawning gravels and filling of pools and estuaries.

Channel widening and loss of pool-riffle sequence due to sedimentation has damaged spawning and rearing habitat of all salmonids. By 1980, the pool-riffle sequence and pool quality in some California streams still had not fully recovered from the 1964 regional flood. In fact, Lisle (1982) found that many Pacific coast streams continue to show signs of harboring debris flow. Such streams have remained shallow, wide, warm, and unstable since these floods. (extracted from (61 FR 56138)).

Droughts dessicate coho salmon rearing and holding habitats, eliminate fish populations and prevent or delay the opening of stream mouths and lagoons, thus preventing access into the streams by spawning adults (Anderson 1995). The severe drought conditions of 1976-77, exacerbated by existing reduced and degraded habitat, apparently was the cause of much decline and extirpation of coho salmon runs south of San Francisco Bay (Brown *et al*. 1994; Bryant 1994; Smith 1994). Low rainfall during the fall and early winter months coincident with the coho salmon spawning migration season can prevent adult coho salmon access into streams, leading to failed year classes (even if later storms occur). Drought during spring months can landlock outmigrant smolt coho salmon, preventing entry to the ocean and consequently depressing or eliminating year class recruitment (Anderson 1995).

Much of the Pacific coast has experienced drought conditions during the past 8 years, a situation which has undoubtedly contributed to the decline of many salmonid populations. Drought conditions reduce the amount of water available, resulting in reductions (or elimination) of flows needed for adult coho salmon passage, egg incubation, and juvenile rearing and migration. There are indications in tree ring records that droughts more severe than the 6-year drought that California recently experienced occurred in the past (Stine 1994). The key to survival in this type of variable and rapidly changing environment is the evolution of behaviors and life history traits that allow anadromous salmonids to cope with a variety of environmental conditions. Populations that are fragmented or reduced in size and range are more vulnerable to extinction by natural events. Whether recent climatic conditions represent a long-term change that will continue to affect salmonid stocks in the future or whether these changes are short-term environmental fluctuations that can be expected to reverse in the near future remains unclear. (The previous paragraph extracted from (61 FR 56138)).

Major landslides can move and deposit huge amounts of sediment loads over long periods into stream channels that can take decades or centuries to recover, with concomitant long-term detriment to salmon habitats. Natural recovery from these types of events can occur very slowly

(Anderson 1995). Landslides can export woody debris found in the stream and along the streamside by uprooting them, leaving the aquatic habitat heavily impacted and simplified. The landslides also move large amounts of fine sediment which greatly elevates suspended sediment loads over the short term (Pyles *et al*. 1998). This usually results in the temporary loss or filling in of pools, reducing the amount of rearing habitat available for salmonids.

13. Research Activities

Most biological opinions NOAA Fisheries issues recommend specific monitoring, evaluation, and research efforts intended to help gather information that would be used to increase the survival of affected listed fish. In addition, NOAA Fisheries has issued numerous research permits authorizing takes of ESA-listed fish over the last few years (Tables 5 through 8). Authorization for take by itself would not lead to decline of the species. However, the sum of the authorized takes indicate a potentially high level of research effort within the action area. In general, permit holders and applicants provide NOAA Fisheries with high take estimates to compensate for potential inseason changes in research protocols, accidental catastrophic events, and the annual variability in listed fish numbers. Also, most research projects depend on annual funding and the availability of other resources. So, a specific research project, for which take of ESA-listed species is authorized by a permit, may be suspended in a year when funding or resources are not available. As a result, the *actual* take in a given year for most research projects, as provided to NOAA Fisheries in post-season annual reports, is usually less than the authorized level of take in the permits and the related NOAA Fisheries consultation on the issuance of those permits.

The effect of these research activities on listed fish is difficult to assess. Figure 5 shows the proportion of accidental lethal take associated with research on listed salmonids from northern California streams is appropriately low. Despite the fact that fish are harassed and even killed in the course of scientific research, only a small fraction of available habitat is sampled; therefore, only a small proportion of the total population is subject to sampling and the loss to the total population is small (McMichael *et al*. 1998). While threats to listed species vary among sites and populations, altered habitat and water regimes and exotic species are the primary factors affecting native fish fauna (Richter *et al*. 1997; Wilcove *et al*. 1998).

Research activities have a great potential to benefit ESA-listed salmon and steelhead. For example, permitted scientific research can provide data useful for the management and recovery of listed species. Aside from simply increasing what is known about the listed species and their biological requirements, research is essentially the only way to answer key questions associated with difficult resource issues that involve every salmonid life history stage. Further, there is no way to tell if the corrective measures described in the previous sections are working unless they are monitored and no way to design new and better corrective measures if research is not done. The information gained during research and monitoring activities will help resource managers recover listed species. The annual reauthorization of any section 10(a)(1)(A) permit is contingent upon receipt and approval of an annual report containing data on the preceding reporting period's research activities, a description of accomplished research activities, and a description of activities proposed for the forthcoming reporting period. In addition, all permit holders must submit a final report within ninety (90) days of the expiration of their permit summarizing the results of the research and the success of the research relative to its goals.

NOAA Fisheries does not consider scientific research and monitoring efforts (unlike the other factors described in the previous sections) to be a factor contributing to the decline of anadromous salmonids within the action area, and NOAA Fisheries believes that the information derived from the research activities is essential to their survival and recovery. Nonetheless, fish *are* harmed during research activities. And activities that are carried out in a careless or undirected fashion are not likely to benefit the species at all. Therefore, to minimize any harm arising from research activities on the species, NOAA Fisheries imposes conditions in its permits so that permit holders conduct their activities in such a way as to reduce adverse effects—particularly killing as few salmonids as possible. Also, researchers are encouraged to use nonlisted fish species and hatchery fish instead of listed naturally-produced fish when possible. In addition, researchers are required to share fish samples, as well as the results of the scientific research, with other researchers and comanagers in the region as a way to avoid duplicative research efforts and to acquire as much information as possible from the ESA-listed fish sampled. NOAA Fisheries also works with other agencies to coordinate research and thereby prevent duplication of effort.

14. <u>Habitat Restoration</u>
Restoration activities may cause temporary increases in turbidity and alter channel dynamics and stability (Habersack and Nachtnebel 1995; Hilderbrand *et al.* 1997; Powell 1997; Hilderbrand *et al.* 1998); these effects may temporarily stress salmonids. Misguided restoration efforts often fail to produce the intended benefits and can even result in further habitat degradation. Improperly constructed projects typically cause greater adverse effects than the pre-existing condition. The most common reason for this is improper identification of the design flow for the existing channel conditions. However, properly constructed stream restoration projects may increase available habitat, habitat complexity, stabilize channels and streambanks, increase spawning gravels, decrease sedimentation, and increase shade and cover for salmonids. The CDFG has produced a manual for stream restoration projects in California (see CDFG 1998) providing guidance to maximize benefit to salmonids while minimizing risks. The negative effects of habitat restoration activities on anadromous salmonid populations within the action area are probably temporary and minor. Overall, habitat restoration projects are considered to be beneficial to the restoration and recovery of at risk populations.

Since 1996, the National Oceanic and Atmospheric Administration Restoration Center has provided $839,602, through cooperative agreements, for 41 restoration projects within the action area. Types of projects funded include: fish migration barrier removal, fish migration barrier passage, riparian restoration and corridor fencing, salt marsh restoration, oyster reef habitat restoration, and road upgrade and decommissioning. Also, CDFG, other government entities, and private foundations have funded these and other types of restoration activities.

V. EFFECTS OF THE PROPOSED ACTION

The purpose of this section is to identify effects associated with NOAA Fisheries' issuance of scientific research permits on ESA-listed salmonids within the action area. The primary effects of the proposed activities on ESA-listed salmonids will be related to harassment associated with intentional take. Harassment generally leads to stress and other sub-lethal effects and is caused by observing, capturing, and handling fish. Unintentional mortality may occur during handling or after the fish has been released. Based on prior experience with the research techniques and protocols that would be used to conduct the proposed scientific research, no more than five percent of the juvenile salmonids encountered are likely to be killed as an indirect result of being captured and handled and, in most cases, that figure will not exceed three percent. NOAA Fisheries expects that less than one percent of the adults handled will die.

In the first subsection below we will describe effects associated with direct observation techniques - techniques that are the least likely to harm ESA-listed species. In the subsequent subsections we describe general effects associated with specimen handling, followed by additional collection-gear specific effects.

A. Effects Associated with Direct Observation

Provided that visibility and other conditions are sufficient, direct observation is used to gather important data on habitat utilization, behavior, distribution, and for estimating population size and structure. Direct observation can entail walking the side of the water body, or underwater observation techniques such as snorkeling, scuba diving, and video photography. Observing fish by walking the side of the water body is done only on small bodies of water or the littoral zones of large bodies of water. Underwater observation is most frequently used in small lakes, streams, and tidepools, however, can be undertaken efficiently in large, deep water bodies (oceans, rivers, and reservoirs) provided that conditions are adequate (Dolloff *et el*. 1996). Turbidity, turbulence, target species behavior, habitat structure and complexity, hydrology, ambient light, and, perhaps, weather affect the efficiency of direct observation.

Another type of direct observation involves spawning surveys. In these surveys the observer walks directly in the stream during spawning season, as close to the edge as possible, locating redds and carcasses. These surveys usually involve the concurrent observation and notation of spawning salmonids as well. Salmonid carcasses are measured, the sex is determined and scale and tissue samples are usually collected. Redds are usually flagged and the locations recorded. One of the effects of this type of survey is the possible disturbance of redds if the observer accidentally steps on one. If spawning salmonids are present during these surveys then the fish can be unintentionally frightened off by the observer, disrupting their spawning activities or their effort to guard the redd after spawning.

Direct observation is the least intrusive method for determining presence/absence of the species and estimating their relative abundance. Effects of direct observation are generally the shortest-lived among any of the research activities discussed in this section. Videography should induce no effects on ESA-listed fish. Using other forms of direct observations, a cautious observer can effectively obtain data without disrupting the normal behavior of a fish. Fish frightened by observers are likely to seek temporary refuge behind rocks, vegetation, and deep water areas. In extreme cases, some individuals may temporarily leave the particular pool or habitat type when observers are in their area. Researchers minimize the amount of disturbance by moving through areas slowly, thus allowing ample time for fish to reach escape cover. Harassment is the primary form of take associated with these observation activities, and few if any injuries or deaths are expected to occur.

B. Effects Associated with General Capture and Handling

Capturing and handling fish causes them stress, though they typically recover fairly rapidly from the process and, therefore, the overall effects of the handling are generally short-lived. The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the original habitat and the container in which the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma (Kelsch and Shields 1996). Stress on salmonids increases rapidly from handling if the water temperature exceeds 18EC or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process. In addition, when fish are handled by samplers to obtain measurements and other data, it is not uncommon for fish to be dropped on the ground by the handlers because the fish are not sedated enough or properly restrained. This can result in internal injuries, especially in females with developing ovaries (Stickney 1983). An injured fish is more susceptible to developing diseases, which can lead to delayed mortality. Some of the injuries which can lead to disease are the loss of mucus, loss of scales, damage to integument and internal damage (Stickney 1983; Kelsch and Shields 1996). In addition to the risks associated with handling, all fish handled will be exposed to additional risks specific to the various methods of capture described in the following subsection.

C. Collection Gear Specific Effects

Following are descriptions of effects of different capture methods and their associated collection gears. The types of gear are described briefly in the following subsections, for more detailed descriptions, see relevant chapters in Nielsen and Johnson (1983) and Murphy and Willis (1996).

1. Tagging and Marking

The use of passive integrated transponder (PIT) tags, coded wire tags, fin-clips, and biotelemetry transmitters are common to many scientific research efforts using ESA-listed species. Some tags or marks allow biologists to identify groups of fish (e.g., hatchery-produced fish or test fish) and some allow for the identification of individual fish. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish.

a. *PIT Tags*

A PIT tag is an electronic device that relays signals to a receiver; it allows individual fish to be identified whenever they pass a location containing such a receiver (e.g., some fish ladders) without researchers having to handle the fish. The tag is inserted into the body cavity of the fish using a modified hypodermic needle, typically, just in front of the pelvic girdle. The insertion of PIT tags requires that the fish be captured and extensively handled, therefore the fish can be affected by any or all of the associated risks mentioned in the section on capture and handling methods. PIT tags have very little effect on growth, survival, swimming speed, stamina, or behavior (Prentice and Park 1984; Jenkins and Smith 1990; Prentice *et al*. 1990; Prentice *et al*. 1994).

b. *Coded Wire Tags*

Coded wire tags (CWTs) are made of magnetized, stainless-steel wire. They bear distinctive notches that can be coded for such data as species, brood year, hatchery of origin, and so forth (Nielsen 1992). The tags are intended to remain within the animal indefinitely, consequently making them ideal for making long-term, population-level assessments of Pacific Northwest salmon. In salmon, CWTs are injected into the nasal cartilage and, therefore, causes little direct tissue damage (Bergman *et al*. 1968). A major advantage to using CWTs is that external and internal tissue damage from the tag and injections heals rapidly and is minor (Bergman et al. 1968; Fletcher et al. 1987; Buckley and Blankenship 1990). In order for researchers to be able to determine later (after the initial tagging) which fish possess CWTs, it is necessary to mark the fish externally—usually by clipping the adipose fin—when the CWT is implanted (see text below for information on fin clipping). One major disadvantage to recovering data from CWTs is that the fish must be killed in order for the tag to be removed. However, this is not a significant problem for the salmonid population because researchers generally recover CWTs from salmon that have been taken during the course of commercial and recreational harvest, or post-spawning carcass surveys.

c. *Biotelemetry Tags*

Biotelemetry tags (or radio tags)are implanted transmitters which allow one to identify and follow an individual fish continuously and remotely and to gather information on migration and habitat utilization. There are two main ways to implant a tag and they differ in both their characteristics and consequences. The first method of implanting a tag is to slip it into the fish's stomach through the esophagus. Stomach insertion does not cause a wound and does not interfere with swimming. This technique is benign when salmon are in the portion of their spawning migrations during which they do not feed (Nielsen 1992). In addition, for short-term studies, stomach tags allow faster post-tagging recovery and interfere less with normal behavior than do tags attached in other ways. A second common method for implanting a tag is to surgically implant the tag within the body cavity. These tags generally do not interfere with feeding or movement, though the size of the tag and fish do influence effects. However, the surgical procedure is difficult, requiring considerable experience and equipment (Summerfelt and Smith 1990; Nielsen 1992). Because the tag is placed within the body cavity, the tag may injure a fish's internal organs. An improperly positioned incision may cause serious injury to the fish. Also, infections of the sutured incision and the body cavity itself are also possible, especially if the tag and incision are not treated with antibiotics (Chisholm and Hubert 1985; Mellas and Haynes 1985; Summerfelt and Smith 1990). Fish with internal radio tags often die at higher rates than fish tagged by other means because radio tagging is a complicated and stressful process. Mortality is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release. It can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal in direct or subtle ways. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982; Matthews and Reavis 1990; Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance.

d. *Fin Clipping*

Fin clipping is the process of removing part or all of one or more fins to alter a fish's appearance and thus make it identifiable. When entire fins are removed, it is expected that they will never grow back. Alternatively, a permanent mark can be made when only a part of the fin is removed or the end of a fin or a few fin rays are clipped. Although researchers have used all fins for marking at one time or another, the current preference is to clip the adipose, pelvic, or pectoral fins.

Many studies have examined the effects of fin clips on fish growth, survival, and behavior. The results of these studies are somewhat variable; however, it can be said that fin clips do not generally alter fish growth. Moreover, wounds caused by fin clipping usually heal quickly, especially those caused by partial clips. Mortality among fin-clipped fish is also variable. Some immediate mortality may occur during the process, especially if fish have been handled extensively for other purposes (e.g., stomach sampling). Mortality depends on species and ambient conditions. Also, small fishes are more sensitive to handling; Coble (1967) suggested that fish shorter than 90 mm are at particular risk. The degree of mortality among individual fishes also depends on which fin is clipped. Mortality is generally higher when the major median and pectoral fins are clipped. Recovery rates for steelhead were 60 percent when the adipose fin was clipped and 52 percent when the pelvic fin was clipped and dropped markedly when the pectoral, dorsal, and anal fins were clipped (Nicola and Cordone 1973). By convention, an adipose mark has significance in California and implies that a fish has been implanted with a coded-wire tag.

2. <u>Hoop Nets</u>

Hoop nets are cylindrical or conical nets that are distended by a series of hoops or frames covered by web netting. A hoop net has one or more internal funnel shaped throats that are directed inward from the mouth of the net. The throats direct and trap the fish in the back end (codend) of the net. The net is held in place by ropes, weights, or stakes. Hoop nets are typically used in lakes and reservoirs, but are sometime used in river habitats. To increase capture efficiency of highly migratory fish, some hoop nets are set with “wings” of netting attached to the mouth of the net. The wings intercept migrating fish and direct them into the mouth of the net. Typically, fish are removed from hoop nets by scooping the fish out of the internal compartments using a dip net. Hoop nets are most effective for species that are attracted to cover, or other fish, or, when wings are in place. Net construction (size and materials) and placement influence efficiency of hoop nets. Fish captured with hoop nets are generally captured unharmed, though there are some risks associated with hoop nets: small fish can be “gilled” in the netting, captured fish are subject to in-net predation from other fish, or injury by removal of the fish by dip net.

3. <u>Seines</u>

A seine is a net that traps fish by encircling them with a long wall of webbing. Typically, the top edge of a seine has floats, the bottom edge is weighted, and the seine has a brail (wooden pole) on each end. As the net is closed the fish become concentrated in the net. Seines are usually large enough that they are fished by two or more people, though can be small enough to be fished by one person. Generally, seines are set in an arc around the targeted fish and then dragged to shore. Seines are effective for sampling littoral areas of lentic habitats. In lotic habitats, seines are most easily used in areas of low velocity, but can be used in high velocity areas if the brails are held in place while someone approaches the net from upstream, herding fish into the net. To be most effective, a seine needs to be deployed quickly enough that the target species cannot escape the encircling net. Accordingly, habitat structure and complexity negatively influence seine efficiency by reducing the speed at which one deploys a seine and by offering escape cover. Small fish can be gilled in the mesh of a seine. Scales and dermal mucus can be abraded by contacting the net. Fish can be suffocated if they are not quickly removed from the net after the net is removed from the water to process the fish. Also, the fish can be crushed by the handler when removing the net from the water.

4. Trawls

Trawls are cone-shaped, mesh nets that are towed, typically, along benthic habitat (Hayes 1983; Hayes *et al*. 1996). Rectangular doors, attached to the towing cables, keep the mouth of the trawl open. Most trawls are towed behind a boat, but small trawls can be operated by hand. As fish enter the trawl, they tire and fall to the codend of the trawl. Mortality and injury rates associated with trawls can be high, particularly for small or fragile fish. Fish can be crushed by debris or other fish caught in the net. Depending on mesh size, some small fish are able to escape the trawl through the netting. However, not all fish that escape the trawl are uninjured, as fish may be damaged while passing through the netting. Short duration trawl hauls (5 to 10 minutes maximum) may reduce injuries (Hayes 1983; Stickney 1983; Hayes *et al*. 1996).

5. Hook and Line

The use of hook and line (angling) is typically associated with recreational or commercial fishing, but can be used for collecting research samples (Hayes *et al*. 1996). Angling can target specific species or size of fish. Angling has been used in scientific studies for a variety of research activities including conducting radiotelemetry studies, studies of fish genetics, fish mortality and fish population structure and abundance. Another form of hook and line capture is a trotline. A trotline has a main line strung horizontally with short vertical lines (drop lines) attached to it (Hubert 1996). Each of the vertical lines have a baited hook attached to it. Trotlines are used frequently in warmwater inland fisheries and are generally used to capture catfish or common carp. Hook and line captures exercise size selectivity and extreme variability in catch rates. Injuries related to hook and line capture are influenced by hook size and type, bait or lure choice, and species behavior. Common hook and line injuries include damage to the skeletal structure of the mouth, injury to gills, and secondary infections.

6. Electrofisher

Electrofishing is a process by which an electrical current is passed through water in order to stun fish and facilitate capture. It can also be used to guide or block their movements. There are three general systems for electrofishing related to where the electrical generator is maintained: backpack, boat, and shore. Backpack electrofishing is the most common system used for salmonids. Boat and shore electrofishing units often use more current than backpack electrofishing equipment because they are used to cover larger (and deeper) areas and, as a result, potentially have a greater impact on fish. This biological opinion considers only backpack electrofishing.

Two or three technician work together while backpack electrofishing. One person carries the backpack and searches the target habitats with the anode, while one or two others net stunned fish. Operators work in teams to increase the number of fish that may be seen or captured. Working in teams also allows the researcher to net fish before they are subjected to higher electrical fields.

The use of electricity to capture fish is one of the most intrusive and risky methods. This method of capture can result in a variety of effects from simple harassment to injury to the fish (adults and juveniles) and death (reviewed in Reynolds 1996). There are two major forms of injuries from electrofishing; hemorrhages in soft tissues and fractures in hard tissues. Only a few recent studies have examined the long-term effects of electrofishing on salmonid survival and growth (Dalbey *et al*. 1996; Ainslie *et al*. 1998). These studies indicate that although some of the fish suffer spinal injury, few die as a result. Dalbey *et al* (1996), reports that the growth of rainbow trout was markedly lower when there was moderate to severe electrofisher induced spinal injury. Electrofishing can also result in trauma to fish from stress. The stress caused by electrofishing is usually not recognized because the fish often appear normal upon release. Recovery from this stress can take up to several days, and during this time the fish are more vulnerable to predation, and less able to compete for resources. Stress related deaths can also occur within minutes or hours of release, with respiratory failure usually the cause.

The waveform produced by the electrofisher affects injury potential. Continuous direct current or low-frequency (#30 Hz) pulsed direct current have been recommended for electrofishing (Fredenberg 1992; Snyder 1992; Snyder 1995; Dalbey *et al*. 1996) because lower spinal injury rates, particularly in salmonids, occur with these waveforms (Fredenberg 1992; McMichael 1993; Sharber *et al*. 1994; Dalbey *et al*. 1996).

The age or stage of development of the target species affects injury rates too. Electrofishing can have severe effects on adult salmonids, particularly spinal injuries from forced muscle contraction. Sharber and Carothers (1988) reported that electrofishing killed 50 percent of the adult rainbow trout in their study. The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. Smaller fish intercept a smaller head-to-tail potential than larger fish (Sharber and Carothers 1988) and may therefore be subject to lower injury rates (e.g., Hollender and Carline 1994; Dalbey *et al*. 1996; Thompson *et al*. 1997). McMichael *et al*. (1998) found a 5.1 percent injury rate for juvenile steelhead captured by electrofishing in the Yakima River subbasin. Cho *et al*. (2002) showed that electrofishing has dramatic negative effect on survival of eggs from electroshocked females (up to 93 percent mortality) and eggs electrofished post spawning (up to 34 percent mortality).

7. <u>Cast Nets</u>

Cast nets are circular nets with weighted edges. Cast nets are thrown to deploy; the net lands on the surface and sinks rapidly entrapping the fish. Cast nets have a central line that allows the net to be pursed and pulled in. Proper deployment of a cast net requires practice, as it is difficult to throw the net and have it land flat on the water. But once the technique is learned, cast nets are quick and efficient methods for collecting fish. Cast nets are useful in areas that have water free of plants, or rocks, and that have a flat bottom. Small fish caught in cast nets can be gilled. Scales and mucus can be abraded by the net.

8. <u>Dip Nets</u>

Dip Nets are bag shaped nets on a frame attached to a handle. The net is placed under the fish and then lifted from the water in a scooping motion. Dip nets are useful when collecting fish that have been trapped by other methods, such as electrofishing or trap nets. Scales and mucus can be abraded by the net, and fish can be crushed by the frame when the handler is attempting to catch them.

9. Gill Nets

Gill nets are walls of netting held vertically in the water by weights and floats. The mesh of gill nets is relatively large; fish attempt to pass through the mesh and are captured. Fish are caught in the net in one of three ways: (1) gilled - held by mesh slipping behind the opercula, (2) wedged - held by the mesh around the body, or (3) tangled - held by teeth, spines, maxillaries or other protrusions without penetration of the mesh (Nielsen and Johnson 1983). Fish are primarily caught in the net by being gilled. When a fish is gilled the opercula do not open and close efficiently and disrupt respiratory gas exchange, leading to suffocation. Sometimes fish are injured while being removed from a gill net, including damage to internal organs from being squeezed, damage to scales and mucus, and damage to jaws and other protruding segments of the body. Soak time proportionally effects the lethal nature of gill nets (Hubert 1983; Hubert 1996); therefore, short gill nets checked frequently should reduce injury. Since gill nets are highly lethal and stress fish more than other forms of passive gears (Hubert 1996), gill nets should not be the preferred gear for capturing live fish for release.

10. Trammel Nets

Trammel nets are entanglement nets, similar to gill nets. They typically consist of several parallel panels of netting which are suspended from a float line and attached to a lead line. A fish will swim through a larger mesh opening and hit the smaller mesh section. The fish will then push the smaller mesh panel through an opening in the opposite larger mesh panel creating a pocket of mesh that entangles the fish. A major benefit of Trammel nets over gill nets is that most fish captured in a Trammel net are in generally better condition than fish captured in gill nets (Hubert 1983; Hubert 1996). Small fish can get gilled in the inner netting.

11. Traps

There are several common types of traps used to catch fish (e.g., fyke traps, screw traps, and pot gears). Fyke nets, also known as wing nets, frame nets, trap nets, and hoop nets (Hubert 1996). These nets are generally used in shallow waters of lakes and reservoirs, however they can also be used in deep water and in streams with slow currents. Modified fyke nets have frames across them near the mouth for stabilization. Fyke nets have leads or wings of webbing attached to the mouth to guide fish into the enclosure. Fish will swim into the enclosure as they follow the lead or wing in an attempt to get around the netting. Fish captured with fyke and trap nets are less stressed than fish captured with entanglement gears and are usually released unharmed. However, the use of these nets can result in mortality when small fish are gilled in the mesh of the nets.

Screw traps are used in rivers of medium flow to capture fish as they travel downstream. They are large cones attached to a catamaran. Screw traps are manufactured in various diameters (approximately 3-5 feet), and are placed horizontally in the stream bed with the open end of the cone facing upstream. Half of the open end of the cone is above the water. The fish enter the open end and proceed through a corkscrew in the downstream end of the trap. At the end of the corkscrew is a box for live capture, which will hold the fish. The purpose of the corkscrew is to prevent the fish from escaping out the open funnel end of the trap.

Pot gears are traps that are portable and rigid, with small openings for animals to enter and are usually small enough to be carried by hand (Hubert 1996). They are typically weighted with stones and marked by a buoy. Some examples of typical pot gears are lobster pots, minnow traps, slat traps for catfish, eel pots and crab pots. These traps are used to capture fish and crustaceans and are most efficient at capturing bottom-dwelling species seeking food or shelter. Fish are captured in the trap when they pass through a conical shaped funnel to reach a receptacle containing bait. One of the risks associated with the use of pot gears is that the gear can continue to capture animals if it is lost, a process called ghost fishing. Fish caught in the various types of pot traps can be crushed by in-trap weight.

Fish caught in traps experience stress and injury from overcrowding if the traps are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis. Fish caught in traps are vulnerable to in-trap predation by other fish and to predation by mammals, birds, or reptiles that are able to enter the trap.

12. Gastric Lavage

Information on fish diet may be useful in endangered species management. A significant component of diet studies is to know the content of a fish's stomach; the simplest and most primitive method is to kill the fish, surgically remove its stomach, and describe the stomach contents. However, sacrificing ESA-listed fish for diet analyses is not acceptable. Fortunately, there are several nonlethal methods available for determining the diet of listed fish. Most times gastric evacuation entails inserting a tube through the esophagus to the stomach of a fish and then flushing the stomach contents. Alternative methods include the use of emetics, vacuuming the stomach, the use of forceps, or flushing the anus. Kamler and Pope (2001) reviewed several gastric evacuation methods and found that most procedures were relatively safe and effective at removing stomach contents. Some risks associated with gastric lavage include: increased handling time and associated stress; injury to the soft tissues of the esophagus, stomach, or intestine; and, with some techniques, injury to the jaws and anesthetic-related injury. Most reported levels of injury are quite low, frequently zero (reviewed in Kamler and Pope 2001), but Sprague *et al*. (1993) reported 33% mortality in juvenile white sturgeon (*Acipenser transmontanus*) and Hartleb and Moring (1995) reported mortality of 60% in golden shiner (*Notemigonus crysoleucas*). Haley (1998), however, showed that mortality in juvenile sturgeon could be greatly reduced by using smaller, more ductile tubing than used by Sprague *et al*. (1993), and by anesthetizing test fish. Gastric lavage has been used safely, and effectively in salmonids (Meehan 1996; Kamler and Pope 2001). Meehan and Miller (1978) reported 10-15% mortality (after 30 days) in coho salmon that were collected by electrofisher, subjected to gastric lavage, transferred to a laboratory, and held 30 days; it is not possible to determine which factor had the greatest influence on survival.

D. Measures to Reduce the Impacts of the Research Program

Implementation of resulting permits will take ESA-listed salmonids and result in adverse impacts to a number of CCC and SONCC coho salmon, CC Chinook salmon, and CCC and NC steelhead. To minimize the effect of take on ESA-listed salmonids during the research activities that will follow issuance of research permits, NOAA Fisheries shall review each application to ensure that the amount of take authorized is commensurate with the status of the subpopulation of coho salmon, Chinook salmon, and steelhead affected by the action. NOAA Fisheries will issue permits only in accordance with 50 CFR § 222.308(c) for activities that will benefit the recovery of the species. NOAA Fisheries shall require permit applicants to provide a clear description of the purposes and methods of the requested activities to ensure that such activities would further the recovery of coho salmon, Chinook salmon, and steelhead, and to estimate the form and extent of take that may result from such actions. Before issuing a section 10(a)(1)(A) permit under this opinion, NOAA Fisheries will prepare a memorandum which will analyze the expected effects of implementing the proposed action and will tier to this biological opinion when appropriate.

Permits will be issued based on a prioritized research system. Recently NOAA Fisheries published take prohibitions for several West Coast salmonids (65 FR 42422; 67 FR 1116) highlighting the value of research to the recovery process and acknowledging the lack of available research data. NOAA Fisheries (1999b) prioritized types of research needed to address recovery issues (Table 9). NOAA Fisheries believes that information consistent with the prioritized data needs found in Table 9 will make a significant contribution to the body of science on salmonid biology and assist in management decisions that lead to the recovery of salmonids.

NOAA Fisheries shall review the credentials of all applicants for the section 10(a)(1)(A) permits to ensure that only qualified individuals will sample or direct research efforts. Applicants are considered qualified if they can provide evidence of experience working with coho salmon, Chinook salmon, and steelhead, or possibly other salmonids. Individuals not qualified will be required to work under the direct, on-site supervision of a qualified individual. The Permit Holder will ensure that all persons operating under their permit will be familiar with the terms and conditions of the permit. Also, the Permit Holder will insure that all persons operating under their permit will be properly trained and have access to properly maintained state-of-the-art equipment.

NOAA Fisheries has developed guidelines for the use of electrofishing (Appendix A) and will require that all Permit Holders follow the guidelines. Electrofishing in the vicinity of adult ESA-listed salmonids or redds of ESA-listed salmonids will not be allowed.

NOAA Fisheries will include special nondiscretionary terms and conditions to each section 10(a)(1)(A) permit issued for intentional take of CCC or SONCC coho salmon, CC Chinook salmon, or CCC or NC steelhead. NOAA Fisheries believes that the permit conditions are necessary and appropriate to minimize take and the effect of take of ESA-listed salmonids. NOAA Fisheries has developed general permit conditions common to all permits (Appendix B) and will develop project-specific permit conditions for each permit. Adherence to the general permit conditions set forth in Appendix B, and the forthcoming project-specific conditions, will serve to minimize the impacts of taking listed salmonids.

Finally, NOAA Fisheries will monitor actual annual takes of ESA-listed fish species associated with scientific research activities (as provided to NOAA Fisheries in annual reports or by other means) and shall adjust annual permitted take levels if they are deemed to be excessive or if cumulative take levels are determined to operate to the disadvantage of the ESA-listed species.

E. Beneficial Effects of Issuing Research or Enhancement Permits

There must be an obvious benefit to the species in order to consider authorizing the intentional capture of ESA-listed species and potential removal of those individuals from the population. The use of ESA-listed species for scientific research is consistent with the purpose of the ESA when the research facilitates recovery of a listed species. The status reviews for ESA-listed salmonids within the action area lament the lack of data available for making satisfactory management decisions (Weitkamp *et al*. 1995; Busby *et al*. 1996; Myers *et al*. 1998; Adams *et al*. 1999; Adams 2000). The lack of reliable and widespread abundance and trend data is in itself a risk factor for listed salmonids within the action area. Access to useful scientific information is essential to implement the ESA adequately. Scientific information is necessary to reduce uncertainty in determining whether a consultation is to be conducted formally or informally, determining whether a jeopardy threshold is met, when developing terms and conditions, reasonable and prudent measures, and reasonable and prudent alternatives.

In order to facilitate the restoration and recovery of ESA-listed salmonids within the action area, scientific research programs directed toward developing a more robust and complete body of information is needed. Typical research activities permitted by NOAA Fisheries in the past have looked at: presence/absence, population trends, spatial distributions, habitat use, genetics, and population dynamics (relative abundance, reproduction, growth, and mortality). Other types of research likely to be proposed would investigate: diet, behavior, migration patterns, and impacts of resource management practices on ESA-listed salmonids. Resulting information from these types of research projects is valuable when management decisions are being made which might affect salmon. Also, monitoring activities can help NOAA Fisheries to determine if protective actions are assisting in the recovery of listed species within the action area. Having data available to resource managers reduces uncertainty in management decisions. Therefore, research can facilitate recovery.

The risks to ESA-listed salmonids of adverse effects from scientific research are reasonably small and acceptable when compared to the benefits that are expected from the issuance of research permits. NOAA Fisheries believes scientific research will make a significant contribution to the body of science on salmonid biology and assist in management decisions that may lead to the conservation and recovery of salmonids.

VI. CUMULATIVE EFFECTS

Cumulative effects are defined in 50 CFR 402.02 as “those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation”. For the purpose of this analysis, the action area that is the subject of this opinion is the North Central California Coast Recovery Domain and that portion of the Southern Oregon Northern California Coasts Recovery Domain located within the state of California. Future Federal actions, including the ongoing operation of dams, hatcheries, fisheries, water withdrawals, and land management activities will be reviewed through separate section 7 consultation processes and not considered here.

The following is a summary of potential cumulative effects that may affect the listed salmonids in the action area. However, due to the large size of the action area and the many entities and land uses that occur within this area, a precise discussion of reasonably certain to occur actions at the programmatic scale would be speculative and infeasible. NOAA Fisheries will include an analysis of cumulative effects in the tiering documents for each permit issued.

Tribal, state, and local government actions will likely be in the form of legislation, administrative rules or policy initiatives, and may encompass changes in land and water uses and intensity, which could impact listed species or their habitat. Tribal and government actions are subject to political, legislative, and fiscal uncertainties, that will determine participation and, therefore, the effect such actions have on listed species. These realities, added to the geographic scope of the action area which encompasses numerous government entities exercising various authorities and the many private landholdings, make any analysis of cumulative effects difficult and speculative.

Tribal governments will continue to participate in cooperative efforts involving watershed and basin planning designed to improve fish habitat. Tribal governments will need to put into practice comprehensive and beneficial natural resource programs if they are to have measurable positive effects on listed species and their habitat.

The State of California administers the allocation of water resources within its borders. Many streams in the action area are over-appropriated (Figure 6) and water resource development has increased in recent years. State and local governments are cooperating with each other and Federal agencies to increase environmental protections, including better habitat restoration and hatchery and harvest reforms. NOAA Fisheries also cooperates with the state water resource management agencies in assessing water resource needs in the action area and in developing flow requirements that will benefit listed fish. During low-water years, however, there may not be enough flow to meet the needs of fish. Moreover, these government efforts could be reduced or even discontinued, so their cumulative effect on listed fish is unpredictable.

Local governments will be faced with similar, but more direct pressures from population growth and movement. The reaction of local governments to such pressures is difficult to assess at this time. In the past, local governments in the action area generally accommodated additional growth in ways that adversely affected listed fish habitat. Also, there is little consistency among local governments in dealing with land use and environmental issues, so any positive effects that local government actions have on listed species and their habitat are likely to be scattered throughout the action area.

A. Urbanization

California is projected to be the #1 state in the United States in projected growth of human populations in both percent change and numbers of individuals with nearly 18 million new residents, and a projected increase of more than 55 percent by 2025 (U.S. Census Bureau - www.census.gov). Table 10 shows recent historic human population growth within the action area. Increased human population will: place greater demands in the action area for electricity, water, and land with development potential; increase demand for waste disposal sites; affect water quality directly and indirectly; and increase the need for transportation, communication, and other infrastructure development. In addition, increasing water demands, which has the effect of decreasing stream flows and affecting the quality and quantity of water, will continue to impact salmonid populations in the future throughout the action area. As anthropogenic effects are generally accepted as the major cause for the decline of salmonids within coastal California watersheds, it does not seem likely that these effects will be lessened as the human population growth rate in this area is one of the highest in California.

The effects of private actions are the most uncertain. Private landowners may change, intensify, or diminish their current land and water uses, possibly impacting salmonids and their habitat. Individual landowners may voluntarily initiate actions to improve environmental conditions, or they may abandon or resist any improvement efforts. Their actions may be compelled by new laws, or may arise out of population growth and economic pressures. Changes in ownership patterns will have unknown impacts. NOAA Fisheries is unable to effectively predict the possible effects of private actions.

Another problem with increasing urbanization is waste water discharges. Waste water discharges can result in negative thermal effects, associated organic input into aquatic systems, changes in aquatic invertebrate communities, increased algae and phytoplankton, and elevated coliform bacteria levels. Nonpoint source discharges are known to occur as a result of failing septic systems and other sources throughout the action area. Point source discharges occur at storm water drains or other discrete locations. Sediment input into streams results from bank slope failure along logged streams where vegetation has been removed or from unpaved roads that are poorly maintained. Discharges from identified point sources of wastewater are expected to be conducted under applicable State and Federal laws.

B. Water Withdrawals

It is anticipated that environmental impacts from water withdrawals will continue at their present levels. These impacts will include localized dewatering of stream reaches, entrapment of younger salmonids, and depletion of flows necessary for migration, spawning, rearing, flushing of sediment from spawning gravels, gravel recruitment, and transport of large woody debris. Unprotected or poorly screened water diversions will continue to impact young salmonids with fry being drawn into water pumps or being stuck against the pump's screened intakes.

C. Gravel Mining

It is anticipated that the environmental impacts associated with gravel mining will continue as California's increasing human population continues to place demands on this resource. These impacts include loss of suitable spawning gravels, decreased bedload movement, and increased levels of turbidity as well as direct loss of salmonid habitat due to river channel incision, bank erosion, habitat simplification, and tributary downcutting. The CDFG and NOAA Fisheries is in the process of developing and implementing a more fish friendly gravel mining policy within the action area. However, it is not anticipated that these efforts will lessen the impacts of gravel mining on salmonid populations for the near future.

D. Agriculture

Agricultural activities include grazing, dairy farming and the cultivation of crops. The recent upward trend in the value of dairy and wine related agricultural products is likely to continue as human populations increase, and these industries are expected to persist within the action area. The impacts of this land use on aquatic species include decreased soil stability, loss of shade- and cover-producing riparian vegetation, increased sediment inputs, and elevated coliform bacteria levels. In addition, the placement of temporary dams, used to facilitate water supply for irrigation, may cause migrational barriers for juvenile salmonids or create lentic habitats beneficial to nonnative predatory fish species.

E. Forestry

Although forestry was a significant industry in the action area prior to the 1900s, most current logging is restricted to the mountainous areas of the action area. Future timber harvest activities may have direct, indirect, and cumulative effects by degrading features identified as essential for salmonid habitat. Construction of private unsurfaced roads may be a significant source of sediment input into streams that are habitat for listed salmonids. The level of new road construction cannot be anticipated, but impacts from roads associated with timber harvest operations should decline due to the increased emphasis on protection of aquatic resources and implementation of higher standards for road construction, maintenance and use.

F. Stream Restoration Projects

Restoration activities conducted under the CDFG's Fisheries Habitat Restoration Program are covered under an ESA section 7 consultation with United States Army Corps of Engineers, and are therefore not considered a cumulative effect. Restoration activities may cause temporary increases in turbidity, alter channel dynamics and stability, and temporarily stress salmonids. Properly constructed stream restoration projects may increase available habitat, habitat complexity, stabilize channels and streambanks, increase spawning gravels, decrease sedimentation, and increase shade and cover for salmonids. NOAA Fisheries does not know how many stream enhancement projects are completed outside of the CDFG's program and cannot predict the effects of these projects. Though, the overall effects of these activities are considered beneficial to the long-term viability of salmonid populations.

G. Chemical Use

It is anticipated that chemicals such as pesticides, herbicides, fertilizers, and fire retardants will continue to be used in the action area. Impacts to salmonids may include changes to riparian vegetation and associated organic input into aquatic systems, changes in aquatic invertebrate communities, and increased algae and phytoplankton. Determining the effects of chemical applications is difficult due to the lack of specific information.

H. California Stream Bed Alteration Agreements

The CDFG has recently strengthened the permitting process for activities taking place in, or in the vicinity of, rivers and streams by requiring environmental review. Stream bed alteration agreements are now reviewed in accordance with the California Environmental Quality Act. Implementation of this new program is expected to result in lessened impacts to salmonids from projects such as temporary summer crossings, culvert installation, gravel extraction, and stream bank stabilization projects within the action area.

I. Summary
Non-Federal activities within the action area are expected to increase with a projected 55 percent increase in human population over the next 25 years in California. Thus, NOAA Fisheries assumes that future private and State actions will continue within the action area, but at increasingly higher levels as population density climbs. The cumulative effects in the action area are difficult to analyze considering the large geographic scope of this opinion, the different resource authorities in the action area, the uncertainties associated with government and private actions, and the changing economies of the region. Whether these effects will increase or decrease is a matter of speculation; however, based on the trends identified in this section, the adverse cumulative effects are likely to increase. Although state, tribal and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NOAA Fisheries can consider them "reasonably foreseeable" in its analysis of cumulative effects.

VII. INTEGRATION AND SYNTHESIS OF EFFECTS

Populations of coho salmon, steelhead and Chinook salmon in California have declined drastically over the last century and some subpopulations of salmonids have been lost. Within the action area, there are five ESUs of salmonids listed as threatened under the ESA. The current status of listed salmonids in California, based upon their risk of extinction, has not significantly improved since the species were listed and may have deteriorated. This severe decline in population over many years demonstrates the need for actions which will assist in the recovery of all of the listed salmonids in the action area, and that if measures are not taken to reverse these trends, the continued existence of these species could be at risk.

A major cause of the decline of west coast anadromous salmonids is the loss or severe decrease in quality and function of essential habitat. Most of this habitat loss and degradation has resulted from anthropogenic watershed disturbances caused by agriculture, forestry, urban development, water diversion, erosion and flood control, dams, and gravel mining. Most of this habitat degradation is associated with the loss of essential habitat components necessary for the survival of anadromous salmonids.

The present body of scientific information relative to the abundance, distribution, and genetic composition of anadromous salmonid populations in coastal northern California is sparse at best. This paucity of data limits the ability of managers to evaluate proposed recovery actions. In order to facilitate the restoration and recovery of ESA-listed salmonids in coastal northern California, a mechanism directed toward developing a more robust and complete body of information is needed.

NOAA Fisheries SWR proposes to issue permits that would implement various monitoring programs for listed salmonids in the coastal northern California. This information can improve the knowledge of coho salmon, Chinook salmon, and steelhead life history, their biological requirements, genetic structure, migration timing, population estimates or trends, and distribution in this coastal drainage of California. Also, the information can help NOAA Fisheries determine if protective actions are assisting in the recovery of listed species in the action area.

To expedite the process of issuing permits, NOAA Fisheries is using a programmatic consultation. The objective of this biological opinion is to determine whether issuance of research permits will reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. Specifically, this opinion evaluates the impacts from authorizing take through the gathering of scientific information under section 10(a)(1)(A) of the ESA for purposes of enhancing recovery of listed salmonid species in the action area.

Specific activities involving take of ESA-listed salmonids authorized by these permits may include: surveys by direct observation, capture by standard fishery gears, tagging, and other activities necessary to conduct studies aimed at the recovery of the species. The effect of this proposed action will consist of temporary behavior modification and rare instances of physical damage and/or possible mortality as a result of harassment, capture, or handling of individual fish. The potential impacts to ESA-listed salmonids are expected to be confined to specific sampling sites within the action area.

Detrimental impacts of the action will be minimized or eliminated by issuing permits based upon a prioritized research system, requiring research be conducted consistently with relevant NOAA Fisheries' guidelines, and specifying terms and conditions in each permit that will minimize the effect of taking on individuals to the maximum extent possible. Although proposed research activities may have an adverse impact on listed salmonids, NOAA Fisheries would restrict issuance of permits to only those entities performing activities that facilitate the recovery of ESA-listed salmonids. If the impacts are realized, they are unlikely to reduce the potential for CCC coho salmon, SONCC coho salmon, CC Chinook salmon, CCC steelhead, or NC steelhead to survive and recover on an ESU scale. NOAA Fisheries believes that the studies implemented after issuance of the permits will make a significant contribution to the body of scientific knowledge and assist in conservation and management decisions that may lead to the recovery of ESA-listed salmonids in coastal northern California.

VIII. CONCLUSION

After reviewing the best available science and commercial data regarding the current status of the threatened CCC and SONCC coho salmon, CC Chinook salmon, and CCC and NC steelhead, the environmental baseline for the action area, the effects of issuance or modification to section 10(a)(1)(A) permits, and cumulative effects, it is NOAA Fisheries' biological opinion that issuance of section 10(a)(1)(A) permits, as proposed, is not likely to jeopardize the continued existence of threatened CCC coho salmon, SONCC coho salmon, CC Chinook salmon, CCC steelhead, or NC steelhead.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. NOAA Fisheries interprets the term "harm" as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.

The issuance of section 10(a)(1)(A) permits or permit modifications are for intentional take of listed CCC coho salmon, SONCC coho salmon, CC Chinook salmon, CCC steelhead, and NC steelhead associated with scientific research and enhancement activities. Where there is overlap of listed salmonids in a given habitat, the permit authorizes take of all listed salmonids. Taking of threatened or endangered species that is incidental to and no intended as part of the proposed action is not anticipated. This opinion does not authorize any taking of a listed species under section 10(a) or immunize any actions from the prohibitions of section 9(a) of the ESA.

X. REINITIATION OF CONSULTATION

This concludes formal consultation on the issuance of scientific research permits for activities within the North-central California Coast Recovery Domain and that portion of the Southern Oregon/Northern California Coasts Recovery Domain located within the state of California. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, NOAA Fisheries must immediately reinitiate consultation.

XI. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

NOAA Fisheries recommends that NOAA Fisheries SWR develop and implement outreach programs promoting conservation and recovery of listed salmonids. Also, NOAA Fisheries recommends that NOAA Fisheries SWR Research and Enhancement Permit Coordinator meet regularly with the North-central California Coast Recovery Coordinator and the Southern Oregon/Northern California Recovery Coordinator to ensure that the research priorities and recommendations of the NOAA Fisheries Technical Recovery Teams are considered when issuing or modifying section 10(a)(1)(A) permits. These conservation recommendations can help offset the short-term, negative impacts of take for purposes of gathering fisheries management information on threatened CCC coho salmon, SONCC coho salmon, CC Chinook salmon, CCC steelhead, NC steelhead, and other associated species.

In order for NOAA Fisheries to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NOAA Fisheries requests notification of implementation of any conservation recommendations.

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XIII. FEDERAL REGISTER NOTICES CITED

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Volume 61 pages 4721-4725. February 7, 1996. National Marine Fisheries Service. Notice: Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act.

Volume 61 pages 56138-56149. October 31, 1996. National Marine Fisheries Service. Final Rule: Threatened Status for Central California Coast Coho Salmon Evolutionary Significant Unit.

Volume 62 pages 1296-1297. January 9, 1997. National Marine Fisheries Service. Correction: Threatened Status for Central California Coast Coho Salmon Evolutionarily Significant Unit (ESU).

Volume 62 pages 24588-24609. May 6, 1997. National Marine Fisheries Service. Final Rule: Threatened Status for Southern Oregon/Northern California Coasts Evolutionary Significant Unit of Coho Salmon.

Volume 62 pages 38479-38485. July 18, 1997. National Marine Fisheries Service. Interim Rule Governing Take of the Threatened Southern Oregon/Northern California Coast Evolutionarily Significant Unit (ESU) of Coho Salmon.

Volume 62 pages 43937-43954. August 18, 1997. National Marine Fisheries Service. Final Rule: Listing of Several Evolutionary Significant Units of West Coast Steelhead.

Volume 63 pages 11482-11520. March 9, 1998. National Marine Fisheries Service. Proposed Rule: Proposed Endangered Status for Two Chinook Salmon Evolutionary Significant Units and Proposed Threatened Status for Five Chinook Salmon Evolutionary Significant Units, Proposed Redefinition, Threatened Status, and Revision of Habitat for One Chinook Salmon Evolutionary Significant Unit; Proposed Designation of Chinook Salmon Habitat in California, Oregon, Washington, and Idaho.

Volume 64 pages 24049-24062. May 5, 1999. National Marine Fisheries Service. Final Rule and Correction: Designated Habitat for Central California Coast Coho and Southern Oregon/Northern California Coast Coho Salmon.

Volume 64 pages 50394-50415. November 15, 1999. National Marine Fisheries Service. Final Rule: Threatened Status for Two Chinook Salmon Evolutionary Significant Units in California.

Volume 64 pages 73479-73506. December 30, 1999. National Marine Fisheries Service. Proposed Rule: Proposed 4 (d) Rules for 7 Threatened Evolutionary Significant Units of West Coast Steelhead.

Volume 65 pages 7764-7787. February 16, 2000. National Marine Fisheries Service. Final Rule: Designated Habitat for 19 Evolutionary Significant Units of Salmon and Steelhead in Washington, Oregon, Idaho, and California.

Volume 65 pages 36074-36094. June 7, 2000. National Marine Fisheries Service. Final Rule: Threatened Status for One Steelhead Evolutionarily Significant Unit (ESU) in California.

Volume 65 pages 42422-42481. July 10, 2000. National Marine Fisheries Service. Final Rule: Governing Take of 14 Threatened Salmon and Steelhead Evolutionary Significant Units.

Volume 66 pages 43150-43170. August 17, 2001. National Marine Fisheries Service. Proposed Rule: Governing Take of Four Threatened Evolutionarily Significant Units (ESUs) of West Coast Salmonids.

Volume 67 pages 1116-1133. January 9, 2002. National Marine Fisheries Service. Final Rule: Governing Take of Four Threatened Evolutionarily Significant Units (ESUs) of West Coast Salmonids.

FIGURES AND TABLES

Following are the figures and tables used in this document.

Figure 1. Map illustrating the action area considered in this consultation. Specific boundaries of the action area are described in the section of this document entitled "Description of the Proposed Action."

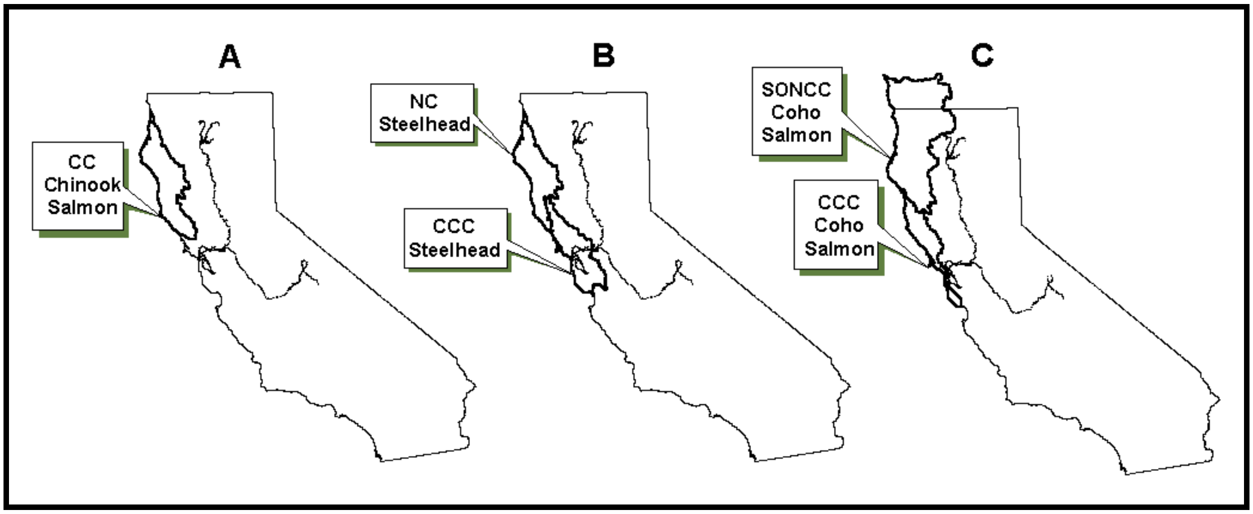

Figure 2. Maps illustrating the geographic boundaries and relative positions of various Evolutionarily Significant Units of salmonids in California. Specific boundaries of the featured Evolutionarily Significant Units are described in the section of this document entitled "Description and Status of the Species and Critical Habitat."

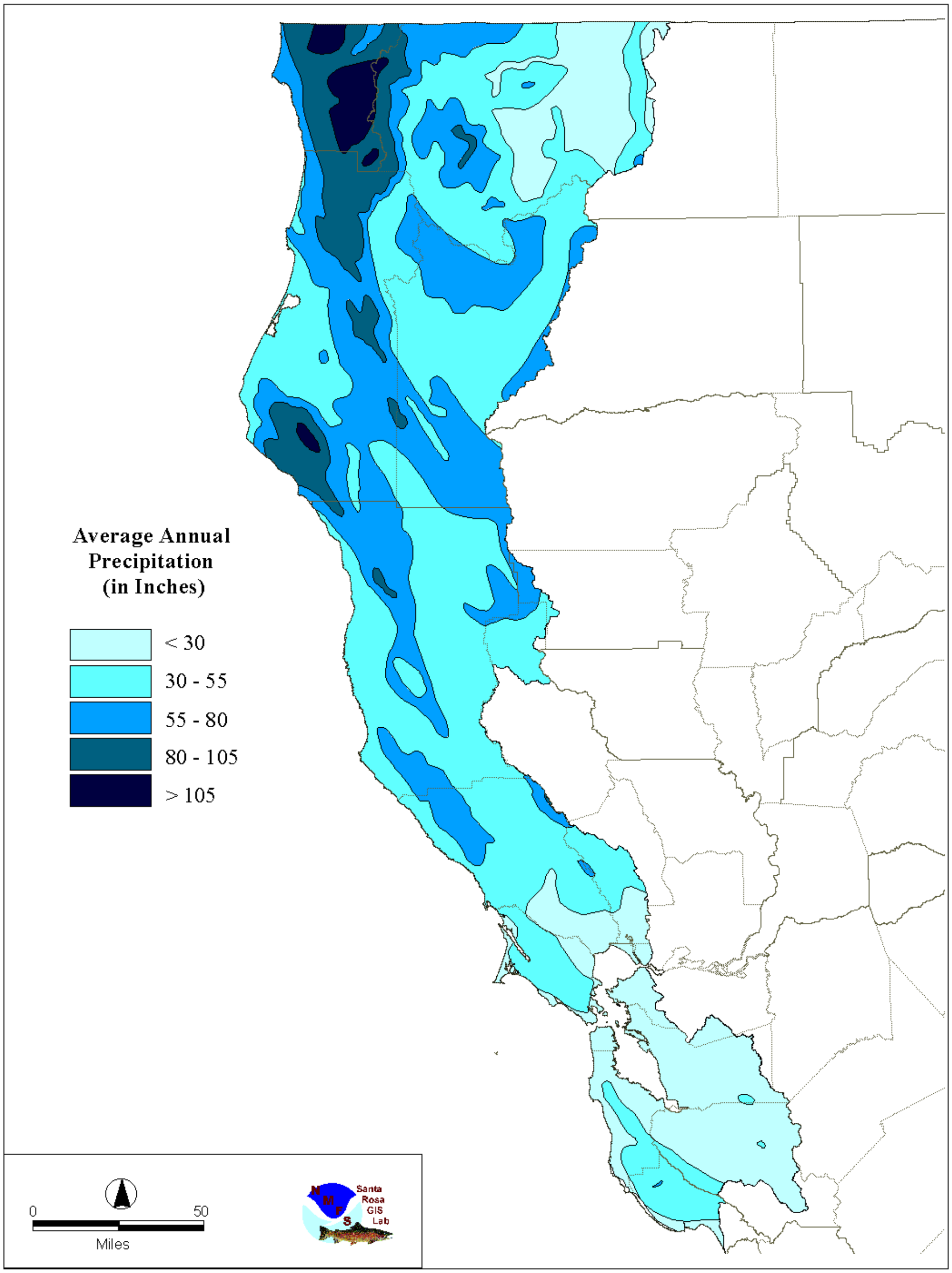

Figure 3. Average (mean) annual precipitation in inches within the action area considered in this consultation. [Source: California Department of Forestry and Fire Protection.]

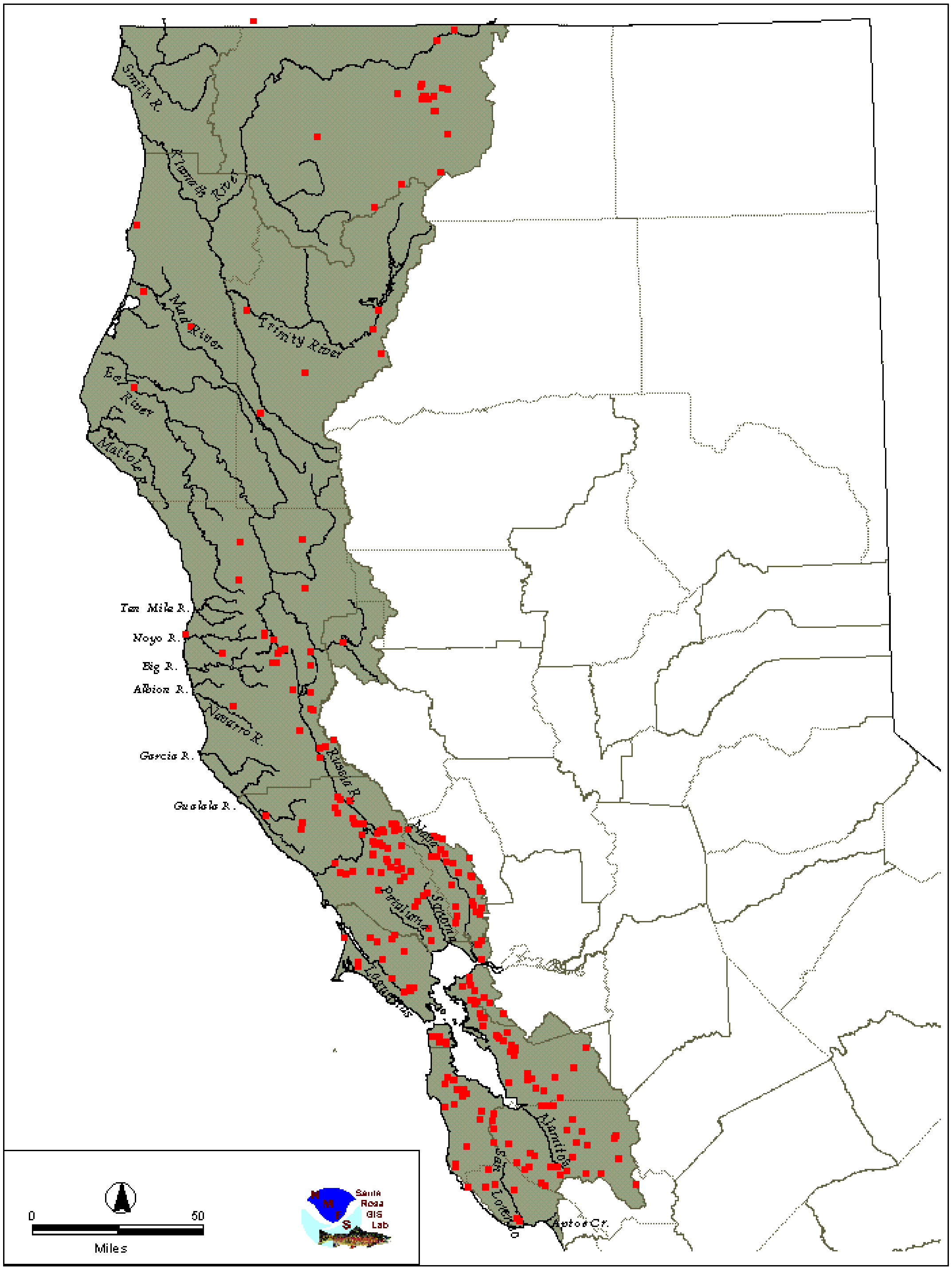

Figure 4. Licensed and registered dams within the action area considered in this consultation. [Source: United States Environmental Protection Agency BASINS version 2.0.]

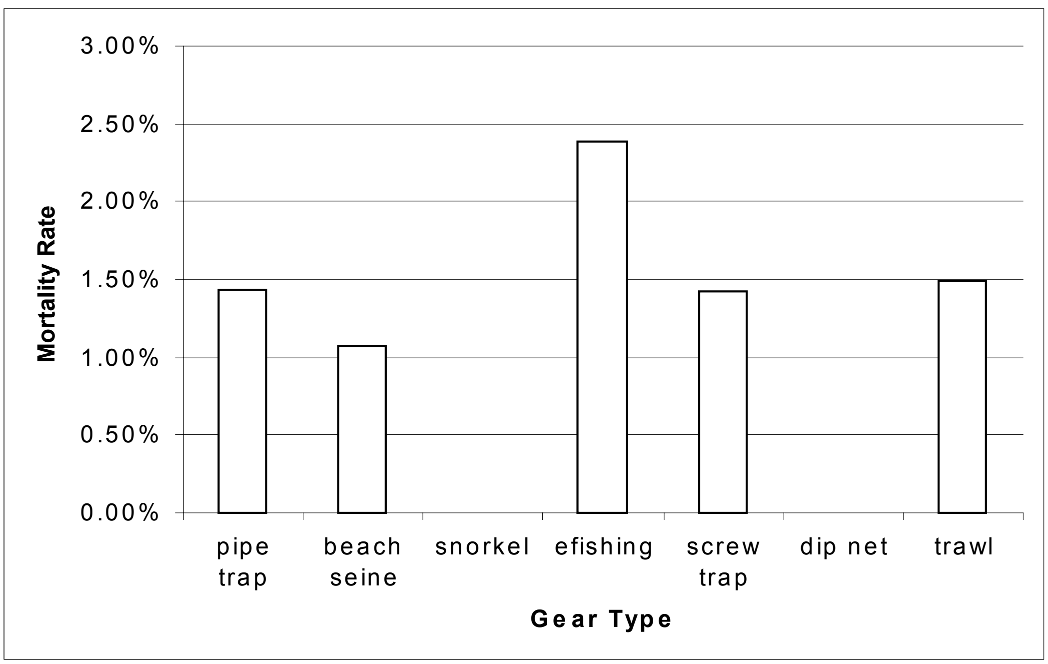

Figure 5. Mortality rate of Chinook salmon, coho salmon, and steelhead (combined) by gear type from northern California streams. [Source: annual reports from several California-based holders of NOAA Fisheries-issued Endangered Species Act research permits.]

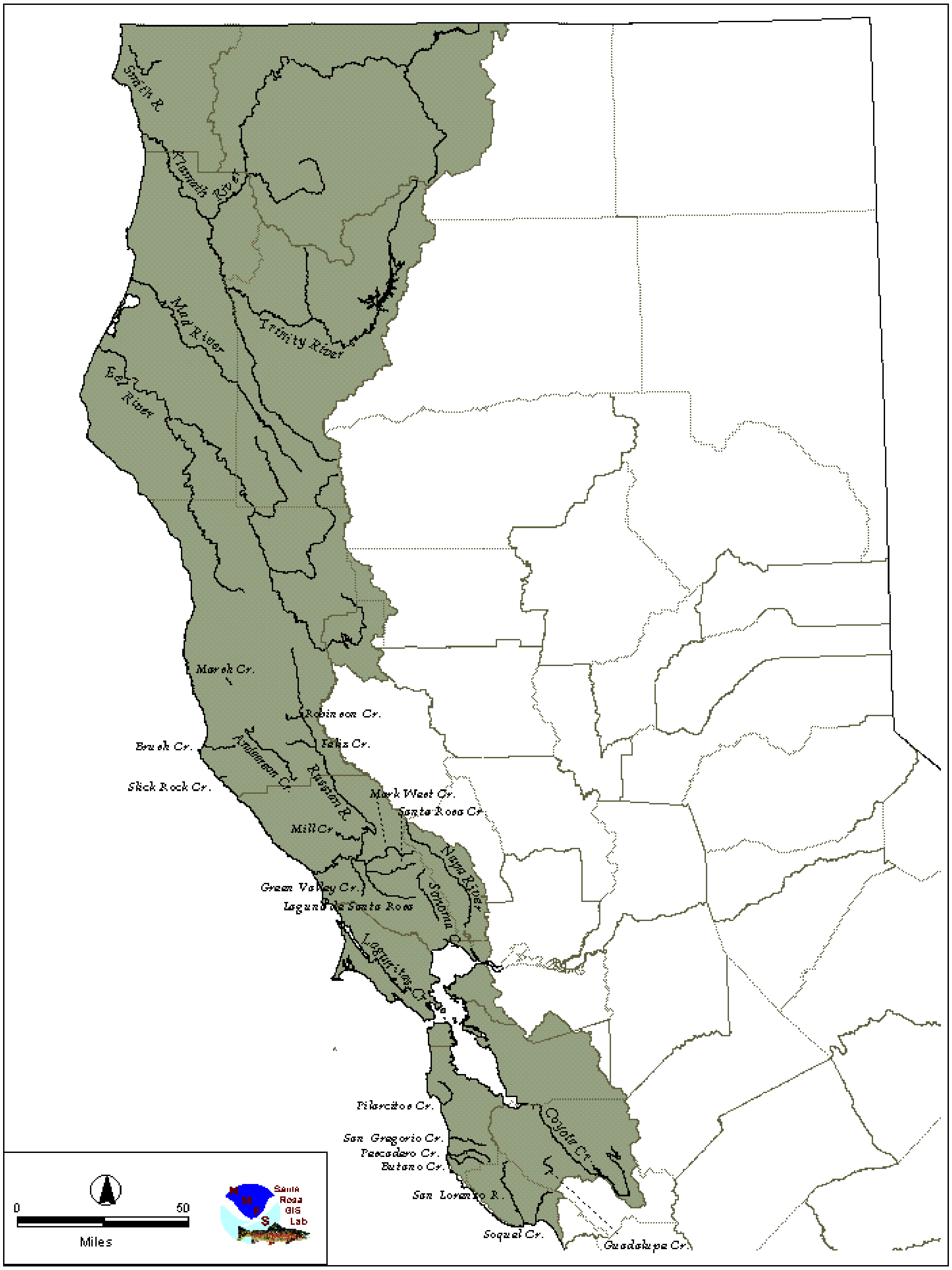

Figure 6. Fully appropriated streams within the action area considered within this consultation. [Source: United States Environmental Protection Agency BASINS version 2.0.]

Table 1. References for additional background on listing status, critical habitat, protective regulations, and biological information for the listed species addressed in this opinion.

ESU	Listing Status	Critical Habitat	Protective Regulations	Biological Information
SONCC coho salmon	Threatened May 6, 1997 62 FR 24588	May 5, 1999 64 FR 24049	Jul 18, 1997 62 FR 38479	Hassler 1987; Sandercock 1991; Weitkamp *et al.* 1995; NOAA Fisheries 2001
CCC coho salmon	Threatened Oct 31, 1996 61 FR 56138	May 5, 1999 64 FR 24049	Oct 31, 1996 61 FR 56138	Shapovalov & Taft 1954; Hassler 1987; Sandercock 1991; Weitkamp *et al.* 1995; NOAA Fisheries 2001
CC Chinook salmon	Threatened Sep 16, 1999 64 FR 50394	Feb 16, 2000 65 FR 7764[4]	Jan 9, 2002 67 FR 1116	Allen and Hassler 1986; Healey 1991; Myers *et al.* 1998; NOAA Fisheries 1999
NC steelhead	Threatened Aug 7, 2000 65 FR 36074	not designated	Jan 9, 2002 67 FR 1116	Barnhart 1986; Busby *et al.* 1996; NOAA Fisheries 1997
CCC steelhead	Threatened Aug 18, 1997 62 FR 43937	Feb 16, 2000 65 FR 7764[3]	Sep 8, 2000 65 FR 42422	Barnhart 1986; Busby *et al.* 1996; NOAA Fisheries 1997; Shapovalov & Taft 1954

[4] On April 30, 2002, critical habitat designation for the CC Chinook salmon ESU and CCC steelhead ESU, among others, was vacated by the Washington D.C. District Court, resolving claims challenging the process by which NOAA Fisheries designates critical habitat.

Table 2. Regional summary of 1980s average coho salmon spawner abundance in California. Numbers are subdivided by the apparent origin of the fish (probably native, mixture of native and naturalized, or hatchery). Based on data from Brown *et al.* (1994).

Region	Probably native	Native and naturalized	Hatchery	Total
Del Norte County	1,000	1,860	16,265	19,125
Humboldt County	3,480	740	891	5,111
Subtotal North of Punta Gorda* (SONCC ESU)	4,480	2,600	17,156	24,236
Mendocino County	160	4,790	0	4,950
Sonoma County	0	635	332	967
Marin County	0	435	0	435
San Francisco Bay	0	0	0	0
South of S.F. Bay	0	140	0	140
Subtotal South of Punta Gorda (CCC ESU)	160	6,000	332	6,492
Total Spawners	4,640	8,600	17,488	30,728

* A few minor coastal streams in Humboldt County south of Punta Gorda are included in this subtotal.

Table 3. Regional summary of numbers of California streams with recent presence or absence of coho salmon among those identified as having supported coho salmon populations in the past. Percentages (in parentheses) are based only on those streams for which recent data are available. Based on data from Brown *et al.* (1994).

Region	Coho present	Coho absent	Total with recent data	No recent data	Total
Del Norte County	24 (55%)	20 (45%)	44	119	163
Humboldt County	49 (69%)	22 (31%)	71	162	233
Subtotal North of Punta Gorda [a]	73 (64%)	42 (36%)	115	281	396
Mendocino County	46 (59%)	32 (41%)	78	25	103
Sonoma County	4 (14%)	24 (86%)	28	25	53
Marin County	7 (100%)	0 (0%)	7	3	10
San Francisco Bay [b]	0 (0%)	7 (100%)	7	0	7
South of S. F. Bay	5 (38%)	8 (62%)	13	0	13
Subtotal South of Punta Gorda	62 (47%)	71 (53%)	133	53	186
Total Streams	135 (54%)	113 (46%)	248	334	582

a A few minor coastal streams in Humboldt County south of Punta Gorda are included in this subtotal.

b Includes Sacramento River.

Table 4. The number of Chinook salmon, by year and life stage, encountered by the Sonoma County Water Agency at Mirabel Dam. Juvenile fish were captured using a screw trap and adult fish were documented from video imagery. For year 2002 data for juvenile Chinook salmon is preliminary and data for adult Chinook salmon have not analyzed to date. [Source: Sonoma County Water Agency unpublished data.]

	Year	Date In	Date Out	Days Sampled	Number Observed
Juvenile	1999	April 21	May 29	21	193
	2000	April 8	June 29	81	1361
	2001	April 20	June 7	47	3722
	2002	March 1	Present	95	18500
Adult	1999	May 20	November 16	180	205
	2000	May 12	January 10	243	1,322
	2001	August 7	November 13	98	1,299
	2002	N/A	N/A	N/A	N/A

Table 5. The amount of intentional take of Southern Oregon/Northern California Coasts coho salmon authorized to 22 permit holders.

Type of Take	Life Stage		
	Juvenile	Adult	Carcass
Observe/Harass	67350	6030	0
Capture, handle, take tissue samples, release	129300	1060	4280
Intentional mortalities	0	0	N/A
Unintentional mortalities	2362	6	N/A
Total take	199012	7096	4280

Table 6. The amount of intentional take of Central California Coast coho salmon authorized to 29 permit holders.

Type of Take	Life Stage		
	Juvenile	Adult	Carcass
Observe/Harass	65450	17220	0
Capture, handle, take tissue samples, release	54715	220	6835
Intentional mortalities	0	0	N/A
Unintentional mortalities	1561	46	N/A
Total take	121726	17486	6835

Table 7. The amount of intentional take of California Coastal Chinook salmon authorized to one permit holder.

Type of Take	Life Stage		
	Juvenile	Adult	Carcass
Observe/Harass	7500	6000	0
Capture, handle, take tissue samples, release	32000	650	150
Intentional mortalities	0	0	N/A
Unintentional mortalities	1500	5	N/A
Total take	41000	6655	150

Table 8. The amount of intentional take of Central California Coast steelhead authorized to one permit holder.

Type of Take	Life Stage		
	Juvenile	Adult	Carcass
Observe/Harass	32300	1050	0
Capture, handle, take tissue samples, release	32000	650	150
Intentional mortalities	0	0	N/A
Unintentional mortalities	1500	5	N/A
Total take	65800	1705	150

Table 9. Desirability and relative cost of various data types for monitoring coastal California salmonids. [Source: Southwest Regional Approach to Data Collection on California Coastal Salmonids (NOAA Fisheries 1999b).]

General Data Type	Specific Data Type	Desirability[5]	Cost[6]
Time Series of Abundance			
	Escapement	A	$$$
	Smolt production	B	$$$
	Juvenile abundance	B	$
Life History Characteristics			
Demographic	Survival (stage-specific)	A	$$
	Age structure	A	$$
	Fecundity	B	$
Habitat Associations	Straying	A	$$
	Migration	C	$$
	Distribution	C	$
Genetic Structure			
	Population delineation or isolation	A	$$
	Hatchery influences	C	$$

5 Relative desirability is rated A, most desirable; B, very desirable; or C, desirable.

6 Relative cost is rated $$$, high cost; $$, moderate cost; or $, low cost.

Table 10. Human population in 2000 of the California counties within the action area of this opinion and the percent growth of human population from 1990 to 2000. [Source: U.S. Census Bureau.]

County	2000 population	percent growth from 1990-2000
Del Norte	27,507	17.3%
Siskiyou	44,301	1.8%
Humboldt	126,518	6.2%
Trinity	13,022	-0.3%
Mendocino	86,265	7.4%
Sonoma	458,614	18.1%
Napa	124,279	12.2%
Marin	247,289	7.5%
Contra Costa	948,816	18.1%
Alameda	1,443,741	10.7%
San Francisco	776,733	7.3%
Santa Clara	1,682,585	12.4%
San Mateo	707,161	8.9%
Santa Cruz	255,602	11.3%
totals	6,942,433	. 11.7%

APPENDIX A - NOAA Fisheries Electrofishing Guidelines

All permit holders performing electrofishing in waters containing ESA-listed salmonids will follow these guidelines.

National Marine Fisheries Service Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act

June 2000

Purpose and Scope

The purpose of this document is to provide guidelines for the safe use of backpack electrofishing in waters containing salmonids listed by the National Marine Fisheries Service (NMFS) under the Endangered Species Act (ESA). It is expected that these guidelines will help improve electrofishing technique in ways which will reduce fish injury and increase electrofishing efficiency. These guidelines and sampling protocol were developed from NMFS research experience and input from specialists in the electrofishing industry and fishery researchers. This document outlines electrofishing procedures and guidelines that NMFS has determined to be necessary and advisable when working in freshwater systems where threatened or endangered salmon and steelhead may be found. As such, the guidelines provide a basis for reviewing proposed electrofishing activities submitted to NMFS in the context of ESA Section 10 permit applications as well as scientific research activities proposed for coverage under an ESA Section 4(d) rule.

These guidelines specifically address the use of backpack electrofishers for sampling juvenile or adult salmon and steelhead that are not in spawning condition. Electrofishing in the vicinity of adult salmonids in spawning condition and electrofishing near redds are not discussed as there is no justifiable basis for permitting these activities except in very limited situations (e.g., collecting brood stock, fish rescue, etc.). The guidelines also address sampling and fish handling protocols typically employed in electrofishing studies. While the guidelines contain many specifics, they are not intended to serve as an electrofishing manual and do not eliminate the need for good judgement in the field.

Finally, it is important to note that researchers wishing to use electrofishing in waters containing listed salmon and steelhead are not necessarily precluded from using techniques or equipment not addressed in these guidelines (e.g., boat electrofishers). However, prior to authorizing the take of listed salmonids under the ESA, NMFS will require substantial proof that such techniques/equipment are clearly necessary for a particular study and that adequate safeguards will be in place to protect threatened or endangered salmonids. Additional information regarding these guidelines or other research issues dealing with salmon and steelhead listed under the ESA can be obtained from NMFS' Protected Resources Divisions in:

Washington, Oregon, and Idaho
Leslie Schaeffer
National Marine Fisheries Service
525 NE Oregon Street, Suite 500
Portland, Oregon 97232-2737
(503) 230-5433 – telephone
Internet Address:
leslie.schaeffer@noaa.gov

California
Daniel Logan
National Marine Fisheries Service
777 Sonoma Ave., Room 325
Santa Rosa, California 95404-6515
(707) 575-6053 – telephone
Internet Address: dan.logan@noaa.gov

Appropriateness of Electrofishing
Backpack electrofishing for salmonids has been a principal sampling technique for decades, however, recent ESA listings underscore the need to regulate the technique and assess its risks and benefits to listed species (Nielsen 1998). With over 25 Evolutionarily Significant Units (ESUs) of threatened or endangered salmonids now identified along the U.S. West Coast, researchers can expect to encounter one or more listed species in nearly every river basin in California, Oregon, Washington, and Idaho. There are few if any non-invasive ways to collect distribution, abundance, or morphophysiological data on salmonids in freshwater. This is reflected in the requirement that all activities that involve intentional take of juvenile salmonids for research or enhancement of an ESA listed species require an ESA Section 10 permit from NMFS. While NMFS has not precluded the use of electrofishing in all cases, researchers must present rigorous study designs and methods for handling fish prior to NMFS authorizing electrofishing to take listed salmonids under the ESA.

NMFS believes there is ample evidence that electrofishing can cause serious harm to fish and the general agency position is to encourage researchers to seek out other less invasive ways to sample listed species. Direct observation by snorkeling is one of the least invasive ways to collect information concerning abundance and distribution, although there can be both practical (e.g., poor viability) and statistical (e.g., large numbers of fish, low observation probability) constraints to direct observation. Preliminary efforts should be directed at study designs that use less invasive methods. If such methods cannot provide the quality of data required or when the benefit exceeds potential mortality risk, then electrofishing can be considered. Electrofishing used on a limited basis to calibrate direct observations (e.g., Hankin and Reeves 1988) is commonly used and methods are currently under development that increase the use of direct observation counts (e.g., bounded counts, "multiple snorkel passes") which, in many cases, will further reduce the need for electrofishing.

Electrofishing Guidelines
Training
Field supervisors and crew members must have appropriate training and experience with electrofishing techniques. Training for field supervisors can be acquired from programs such as those offered from the U.S. Fish and Wildlife Service - National Conservation Training Center (Principles and Techniques of Electrofishing course) where participants are presented information concerning such topics as electric circuit and field theory, safety training, and fish

injury awareness and minimization. A crew leader having at least 100 hours of electrofishing experience in the field using similar equipment must train the crew. The crew leader's experience must be documented and available for confirmation; such documentation may be in the form of a logbook. The training must occur before an inexperienced crew begins any electrofishing and should be conducted in waters that do not contain ESA-listed fish. Field crew training must include the following elements:

1. A review of these guidelines and the equipment manufacturer's recommendations, including basic gear maintenance.

2. Definitions of basic terminology (e.g., galvanotaxis, narcosis, and tetany) and an explanation of how electrofishing attracts fish.

3. A demonstration of the proper use of electrofishing equipment (including an explanation of how gear can injure fish and how to recognize signs of injury) and of the role each crew member performs.

4. A demonstration of proper fish handling, anesthetization, and resuscitation techniques.

5. A field session where new individuals actually perform each role on the electrofishing crew.

Research Coordination
Research activities should be coordinated with fishery personnel from other agencies/parties to avoid duplication of effort, oversampling small populations, and unnecessary stress on fish. Researchers should actively seek out ways to share data on threatened and endangered species so that fish samples yield as much information as possible to the research community. NMFS believes that the state fishery agencies should play a major role in coordinating salmonid research and encourages researchers to discuss their study plans with these agencies prior to approaching NMFS for an ESA permit.

Initial Site Surveys and Equipment Settings
1. In order to avoid contact with spawning adults or active redds, researchers must conduct a careful visual survey of the area to be sampled before beginning electrofishing.

2. Prior to the start of sampling at a new location, water temperature and conductivity measurements should be taken to evaluate electroshocker settings and adjustments. No electrofishing should occur when water temperatures are above 18°C or are expected to rise above this temperature prior to concluding the electrofishing survey. In addition, studies by NMFS scientists indicate that no electrofishing should occur in California coastal basins when conductivity is above 350 FS/cm.

3. Whenever possible, a block net should be placed below the area being sampled to capture stunned fish that may drift downstream.

4. Equipment must be in good working condition and operators should go through the manufacturer's preseason checks, adhere to all provisions, and record major maintenance work in a logbook.

5. Each electrofishing session must start with all settings (voltage, pulse width, and pulse rate) set to the minimums needed to capture fish. These settings should be gradually increased only to the point where fish are immobilized and captured, and generally not allowed to exceed conductivity-based maxima (Table 1). Only direct current (DC) or pulsed direct current (PDC) should be used.

Table 1. Guidelines for initial and maximum settings for backpack electrofishing.

Parameter	*Initial Settings*	*Maximum Settings*		*Notes*
Voltage	100 V	Conductivity (µS/cm)	Max. Voltage	In California coastal basins, settings should never exceed 400 volts. Also, no electrofishing should occur in these basins if conductivity is greater than 350 µS/cm.
		< 100	1100 V	
		100 - 300	800 V	
		> 300	400 V	
Pulse width	500 µs	5 ms		
Pulse rate	30 Hz	70 Hz		In general, exceeding 40 Hz will injure more fish

Electrofishing Technique

1. Sampling should begin using straight DC. Remember that the power needs to remain on until the fish is netted when using straight DC. If fish capture is unsuccessful with initial low voltage, gradually increase voltage settings with straight DC.

2. If fish capture is not successful with the use of straight DC, then set the electrofisher to lower voltages with PDC. If fish capture is unsuccessful with low voltages, increase pulse width, voltage, and pulse frequency (duration, amplitude, and frequency).

3. Electrofishing should be performed in a manner that minimizes harm to the fish. Stream segments should be sampled systematically, moving the anode continuously in a herringbone pattern (where feasible) through the water. Care should be taken when fishing in areas with high fish concentrations, structure (e.g., wood, undercut banks) and in shallow waters where most backpack electrofishing for juvenile salmonids occurs. Voltage gradients may be high when electrodes are in shallow water where boundary layers (water surface and substrate) tend to intensify the electrical field.

4. Do not electrofish in one location for an extended period (e.g., undercut banks) and regularly check block nets for immobilized fish.

5. Fish should not make contact with the anode. Remember that the zone of potential injury for fish is 0.5 m from the anode.

6. Electrofishing crews should be generally observant of the condition of the fish and change or terminate sampling when experiencing problems with fish recovery time, banding, injury, mortality, or other indications of fish stress.

7. Netters should not allow the fish to remain in the electrical field any longer than necessary by removing stunned fish from the water immediately after netting.

Sample Processing and Recordkeeping

1. Fish should be processed as soon as possible after capture to minimize stress. This may require a larger crew size.

2. All sampling procedures must have a protocol for protecting held fish. Samplers must be aware of the conditions in the containers holding fish; air pumps, water transfers, etc., should be used as necessary to maintain safe conditions. Also, large fish should be kept separate from smaller prey-sized fish to avoid predation during containment.

3. Use of an approved anesthetic can reduce fish stress and is recommended, particularly if additional handling of fish is required (e.g., length and weight measurements, scale samples, fin clips, tagging).

4. Fish should be handled properly (e.g., wetting measuring boards, not overcrowding fish in buckets, etc.).

5. Fish should be observed for general condition and injuries (e.g., increased recovery time, dark bands, apparent spinal injuries). Each fish should be completely revived before releasing at the location of capture. A plan for achieving efficient return to appropriate habitat should be developed before each sampling session. Also, every attempt should be made to process and release ESA-listed specimens first.

6. Pertinent water quality (e.g., conductivity and temperature) and sampling notes (e.g., shocker settings, fish condition/injuries/mortalities) should be recorded in a logbook to improve technique and help train new operators. It is important to note that records of injuries or mortalities pertain to the entire electrofishing survey, including the fish sample work-up.

Citations and Other References

Dalbey, S. R., T. E. McMahon, and W. Fredenberg. 1996. Effect of electrofishing pulse shape and electrofishing-induced spinal injury on long-term growth and survival of wild rainbow trout. North American Journal of Fisheries Management 16:560-569.

Hankin, D. G., and G. H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences 45:834-844.

Hollender, B. A., and R. F. Carline. 1994. Injury to wild brook trout by backpack electrofishing. North American Journal of Fisheries Management 14:643-649.

Nielsen, J. L. 1998. Electrofishing California's endangered fish populations. Fisheries 23:6-12. Nielsen, L.A., and D.L. Johnson, editors. 1983. Fisheries techniques. American Fisheries Society, Bethesda, Maryland.

Reynolds, J. B., and A. L. Kolz. 1988. Electrofishing injury to large rainbow trout. North American Journal of Fisheries Management 8:516-518.

Sharber, N. G., and S. W. Carothers. 1988. Influence of electrofishing pulse shape on spinal injuries in adult rainbow trout. North American Journal of Fisheries Management 8:117-122.

Sharber, N. G., S. W. Carothers, J.P. Sharber, J. D. de Bos, Jr., and D. A. House. 1994. Reducing electrofishing-induced injury of rainbow trout. North American Journal of Fisheries Management 14:340-346.

Schreck, C.B., and P.B. Moyle, editors. 1990. Methods for fish biology. American Fisheries Society, Bethesda, Maryland.

APPENDIX B - General Permit Conditions

Following are permit conditions that NOAA Fisheries SWR will include in all ESA section 10(a)(1)(A) permits. Additional project-specific permit conditions will be developed and added to each permit.

A. Permit Reporting and Reauthorization Requirements

The NOAA Fisheries will require all Permit Holders to provide an annual report of the activities conducted under their permits. All Permit Holders must submit periodic reports to NOAA Fisheries describing in detail all research activities undertaken and proposed. All reports and notifications must be sent to: Research Permits Coordinator, Protected Resources Division, 777 Sonoma Avenue, Room 325, Santa Rosa, California 95403, (707) 575-6053, (707) 578-3435 (FAX). For the duration of any permit authorized by this opinion, work in each succeeding year is contingent on submission and approval of a report on each preceding year's research activities. Annual reports are due by October 1 each year. The information provided shall include, but not be limited to:

1. summary presentations and brief discussions of significant research results;

2. maps and/or descriptions of location sampled;

3. the results of all sampling efforts including estimates of population size, if possible;

4. quantification of take, including numbers of individuals intentionally and incidentally killed, including dates, locations, and circumstances of lethal take, and an estimate of the numbers of individuals otherwise harmed or harassed (e.g., handled in a fish trap or displaced during snorkeling surveys);

5. Other pertinent observations made during sampling efforts regarding the status of ecology of the species, including size of individuals and presumed life-history form; and

6. planned future activities if authorized under this permit.

    a. a detailed description of activities conducted under this permit, including the total number of fish taken at each location, an estimate of the number of ESA-listed fish taken at each location, the manner of take, and the dates/locations of take;

    b. measures taken to minimize disturbances to ESA-listed fish and the effectiveness of these measures, the condition of ESA-listed fish taken and used for research, a description of the effects of research activities on the subject species, the disposition of ESA-listed fish in the event of mortality, and a brief narrative of the circumstances surrounding ESA-listed fish injuries or mortalities;

    c. any problems which may have arisen during the research activities, and a statement as to whether or not the activities had any unforeseen effects;

d. a description of how all take estimates were derived;

e. any preliminary analyses of the data;

f. steps that have been and will be taken to coordinate the research with that of other researchers; and

g. if an electroshocker was used for fish collection, a copy of the logbook must be included with the report.

7. The Permit Holder must submit a final report within ninety (90) days of the expiration of this permit summarizing the results of the research and the success of the research relative to its goals.

B. Operational Reports and Notification Requirements

1. The Permit Holder must provide plans for future undefined projects and/or changes in sampling locations or research protocols and obtain approval from NOAA Fisheries prior to implementation.

2. Prior to each research sampling season, the Permit Holder must identify the personnel designated to act under the authority of this permit and confirm their experience through résumés or other evidence of their qualifications.

3. The Permit Holder must provide notice of intended activities at least two weeks in advance of each research sampling season to enable a NOAA Fisheries official(s), or any other person(s) duly designated, to accompany researchers. The required notification shall include a detailed outline of coordination measures that will be undertaken with other researchers to insure that no unnecessary duplication and/or adverse cumulative impacts occur as a result of the research activities.

4. The Permit Holder must report whenever the authorized level of take is exceeded, or if circumstances indicate that such an event is imminent. Notification should be made as soon as possible, but no later than two days after the authorized level of take is exceeded. The Permit Holder must then submit a detailed written report. Pending review of these circumstances, NOAA Fisheries may suspend research activities or amend this permit to allow research activities to continue.

5. The Permit Holder must report the take of any ESA-listed species not included in this permit, when it is killed, injured, or collected during the course of research activities. Notification should be made as soon as possible, but no later than two days after the unauthorized take. The Permit Holder must then submit a detailed written report. Pending review of these circumstances, NOAA Fisheries may suspend research activities or amend this permit to allow research activities to continue.

C. General Conditions

1. The Permit Holder must insure that the ESA-listed species are taken only by the means, in the areas, and for the purposes set forth in the permit application, as limited by the terms and conditions in this permit.

2. The Permit Holder must insure that all ESA-listed species are handled carefully. Should NOAA Fisheries determine that a procedure provided for under this permit is no longer acceptable, the Permit Holder must immediately cease such activity until NOAA Fisheries determines an acceptable substitute procedure.

3. The Permit Holder, in effecting the take authorized by this Permit, is considered to have accepted the terms and conditions of this permit and must be prepared to comply with the provisions of this permit, the applicable regulations, and the ESA.

4. The Permit Holder is responsible for the actions of any individual operating under the authority of this permit. Such actions include capturing, handling, releasing, transporting, maintaining, and caring for any ESA-listed species authorized to be taken by this permit.

5. The Permit Holder, personnel, or designated agent acting on the Permit Holder's behalf must possess a copy of this permit when conducting the activities for which a take of ESA-listed species or other exception to ESA prohibitions is authorized herein.

6. The Permit Holder may not transfer or assign this permit to any other person(s), as person is defined in section 3(12) of the ESA. This permit ceases to be in force or effective if transferred or assigned to any other person without prior authorization from NOAA Fisheries.

7. The Permit Holder must obtain any other Federal, state, and local permits/authorizations necessary for the conduct of the activities provided for in this permit. In addition, before taking ESA-listed species in the territorial waters of a foreign country, the Permit Holder must secure consent from, and comply with the appropriate laws of, that country.

8. Any personnel of the Permit Holder requiring Federal or state licenses to practice their profession must be duly licensed under the appropriate law.

9. The Permit Holder must coordinate with other co-managers and/or researchers to insure that no unnecessary duplication and/or adverse cumulative effects occur as a result of the Permit Holder's activities.

10. The Permit Holder must allow any NOAA Fisheries employee(s) or any other person(s) designated by NOAA Fisheries, to accompany field personnel during the activities provided for in this permit. The Permit Holder must allow such person(s) to inspect the Permit Holder's records and facilities if such records and facilities pertain to ESA-listed species covered by this permit or NOAA Fisheries's responsibilities under the ESA.

11. Under the terms of the regulations, a violation of any of the terms and conditions of this permit will subject the Permit Holder, and/or any individual who is operating under the authority of this permit, to penalties as provided for in the ESA.

12. The Permit Holder is responsible for biological samples collected from ESA-listed species as long as they are useful for research purposes. The terms and conditions concerning any samples collected under this authorization remain in effect as long as the Permit Holder maintains authority and responsibility of the material taken. The Permit Holder may not transfer biological samples to anyone not listed in the application without obtaining prior written approval from NOAA Fisheries. Any such transfer will be subject to such conditions as NOAA Fisheries deems appropriate.

13. The Office of Protected Resources, NOAA Fisheries, may amend the provisions of this permit after reasonable notice to the Permit Holder.

14. 50 CFR Section 222.23(d)(8) allows NOAA Fisheries to charge a reasonable fee to cover the costs of issuing permits under the ESA. The fee for this permit has been waived.

15. NOAA Fisheries may revoke this permit if the activities provided for by it are not carried out, if the activities are not carried out in accordance with the conditions of the permit and the purposes and requirements of the ESA, or if NOAA Fisheries otherwise determines that the findings made under section 10(d) of the ESA no longer hold.

16. Any falsification of annual reports or records pertaining to this permit is a violation of this permit.

17. The Permit Holder, in signing this permit, has accepted and will comply with the provisions of this permit, applicable regulations (50 CFR 222), and the ESA.

D. Penalties and Permit Sanctions

1. Any person who violates any provision of this permit is subject to civil and criminal penalties, permit sanctions, and forfeiture as authorized under the ESA and 15 CFR part 904 [Civil Procedures].

2. All permits are subject to suspension, revocation, modification, and denial in accordance with the provisions of subpart D [Permit Sanctions and Denials] of 15 CFR part 904.